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REPORT 51-12 DECEMBER 1951

DEPARTMENT OF ENGINEERING

masonry failure under impulsive loading

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ON

MASONRY FAILURE UNDER IMPULSIVE LOADING

COMPILED BY

ENGINEERING WEAPONS EFFECTS RESEARCH
SANDIA CORPORATION PURCHASE ORDER DR-169

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FOREWORD

The bibliography presented herewith was compiled by the Department of Engineering, University of California, Los Angeles, under Purchase Order DR-169 with Sandia Corporation of Albuquerque, New Mexico.

Search for and examination of references was done by C.M. Duke, J.M. English, M. Feigen, W.T. Thomson, and A.H. White. Mr. White, with assistance from W.F. Hode, did the work of editing and compilation.

In order that the bibliography shall be as promptly available to the profession as possible, it is issued at this time with the expectation that some inaccuracies and omissions may have escaped the editors. It is believed that these will not materially impair the usefulness.

C. Martin Duke

C. Martin Duke
Project Leader
Weapons Effects Research Project

Robert Bromberg

Robert Bromberg
Technical Representative of the Chairman
Department of Engineering

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PART I

EXPLANATION OF DESIGNATIONS FOR REFERENCES

Example: Ab43

The letters identify the subject classification and its subdivision as listed in the above Table of Contents. In this example the reference gives static test characteristics of plain concrete, mortar, or glass.

The numbers indicate the year of publication. Years prior to 1900 are indicated with four numbers (e.g. Ca 1871).

In keying technical reports to this bibliography, one may use parenthetical reference designations as above and add the author's surname. Thus: (Ab43 Smith).

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PART III. BIBLIOGRAPHY

Aa. STATIC TEST CHARACTERISTICS---BRICKS, CONCRETE BLOCKS

See also: Ea48 Frankel, Af49 "Chalmers Teknisha"

Aa50. "Masonry, Masonry Units, and Mortar," Bureau of Standards letter, Circular 983, April 1950.

A complete listing of papers written by staff members of the Bureau of Standards on the subjects listed.

Aa50. Plummer, Harry C.
"Brick and Tile Engineering," Structural Clay Products Inst., Washington, D. C., 1950. 391pp.

Portions of the handbooks "Brick Engineering" and "Tile Engineering" dealing with nonreinforced masonry only.

Aa48. Forkner, H.R., Hagerman, R.S., Dear, P.S., and Whittemore, J.W.
"Mortar Bond Characteristics of Various Brick," Va. Poly. Inst. Engr. Exp. Sta. Bul. n.70 v.42 n.1 Nov 1948.

Report on tests made to determine physical properties of selected masonry materials, and to study effect of method of forming tension bond strength couplets.

Aa46. Lassettre, Majorie, and Everhart, J.O.
"Stress-Strain relations in Ceramic Materials," Am. Ceramic Soc. J. 39:261-266 1946.

Several types of ceramic materials studied under stress with SR-4 strain gages to measure the strain. Behavior was similar to elastic materials, hard fired materials exhibit straight line deformation; soft fired materials have proportional limit - stress-strain curve deviates from a straight line.

Aa43. Pearson, J.C.
"Measurement of bond between bricks and mortar," Am. Soc. Test Mat. Proc. 43:857-66 1943.

Modified cross brick couplet test and wall test gave results for modulus of rupture and tensile strength in bond.

Aa43. Plummer, H.C., and Reardon, L.J.
"Brick Engineering," Structural Clay Products Inst., 437pp., 1943.

Contains bibliography, review of test data, and design information on brick masonry. Very complete handbook of design.

Aa39. Johnson, John B. (Withey, M.)
"Materials of Construction." Wiley 8th Ed. 867pp. 1939.

Aa35. Withey, M. O.
"Recent Experiments on Masonry Building Materials Made in Materials Testing Laboratory of University of Wisconsin," Assoc. State Engr. Soc. Bul. July 1935.

Aa34. Palmer, L.A., and Parsons, D.A.
"A Study of the Properties of Mortars and Bricks and their Relation to Bond," Bureau of Standards Journal 12:609-644 May 1934.

Aa33. McBurney, J.W., and Lovewell, C.E.
"Strength, Water Absorption and Weather Resistance of Building Brick Produced in the United States," Am. Soc. Test. Mat. Proc. 33pt.II:636 1933.

"Weighted averages and dispersions of the compressive and transverse strengths of the building brick produced in the U.S.".

Aa31. Griffith, John H.
"Strengths of Brick and Other Structural Silicates," Am. Ceramic Soc. J. 14:325-356 May 1931.

Derivation of formula predicting strength. Formula based on sensible pore space determined by degree of absorption of water by weight.

Aa29. "Physical Properties of Brick and Brickwork," Brick Engr. v.1, 1929.

Aa29. McBurney, J.W.
"The Compressive and Transverse Strength of Brick," Am. Ceramic Soc. J. 12:217 1929. Also: Bur. Stand. J. Research 2:821 1929 (RP59).

"No general rule exists for converting values from a compressive test made with a brick on its flat side to the compressive strength with the brick on edge.---- The modulus of rupture can not be determined from a compressive test (nor vice versa) without possibility of great error."

Aa28. McBurney, J.W.
"Strength of Brick in Tension," Am. Ceramic Soc. J. II: 114 1928

"Summary:
(1) An apparatus for making tensile tests on whole bricks is described.
(2) The tensile strengths of several types of brick are given.

(3) The tensile strength of the bricks examined are between 30% and 40% of the modulus of rupture."

Aa27. Stang, A.H.
"A Portable Apparatus for Transverse Tests of Brick,"
Bur. Stand. Tech. Paper n. 341, v. 21, p. 347 (1926-27).

Aa27. Tucker, J., Jr.
"The Compressive Strength of Materials, with Applications,"
Franklin Inst. J. 204:751 Dec 1927.

Aa24. Whittemore, H.L.
"Equalizer Apparatus for Transverse Tests of Bricks,"
Bur. Stand. Tech. Paper n. 251, v. 18 pp. 107-113 (1924-25).

Description of a new equalizer apparatus for making transverse tests of bricks, designed to insure proper loading and alignment, even with warped bricks.

Aa20. Emley and Cleare
"How Brick Piers Fail," Sand-Lime Brick Assoc. Proc. 1920.

Describes apparatus for tensile test of brick and gives some values.

Ab. STATIC TEST CHARACTERISTICS---PLAIN CONCRETE, MORTAR, GLASS

See also: Aa50 "Masonry, Masonry Units, Etc.," Af49 "Chalmers Teknisha---,"

Ab46. Evans, R.H.
"Extensibility and Modulus of Rupture of Concrete,"
Structural Engr v.24, n.12 pp. 636-659 1946.
(Discussion: v.25, n.12 pp. 539-54 Dec. 1947.)

Account of results obtained from tests concerning extensibility of plain and reinforced concrete specimens in tension and bending; data on tests; apparatus and material; tests on briquettes, reinforced tension columns, plain and reinforced beams; results presented in charts. Bibliography. (Very good article.)

Ab46. Vivian, A.C.
"The Stress-Strain Relation of Concrete," J. Inst. Structural Engrs. 24:42-53 Jan. 1946.

Ab43. Washa, G.W.
"Tests of Masonry Cements," Am. Conc. Inst. J. 15:165-71 Nov. 1943.

Ab42. Preston, F.W.
"The Mechanical Properties of Glass," J. App. Physics 13:623-634 1944.

Contains bibliography.

Ab41. Maney, G.A.
"Concrete Under Sustained Working Loads; Evidence that Shrinkage Dominates Time Yield," Am. Soc. Test. Mat. Proc. 41:1021-1031 1941.

Ab41. Smith, F.C., and Brown, R.Q.
"The Shearing Strength of Cement Mortar," Univ. of Washington Engr. Exp. Sta. Bul. n.106, Feb. 1941.

Report of triaxial compression tests on cement mortar; use of Mohr diagram; cohesive strength and angle of internal friction.

Ab39. "Tests on Concrete Masonry Units," Am. Conc. Inst. J. 36:121 Nov. 1939.

This paper presents results of a series of tests to show the effect of two different types of molding, vibration and tamping, on strength and other factors of concrete.

Ab38. Gilkey, H. J., and Murphy, G.
"Stress-strain characteristics of mortars and concretes,"
Am. Soc. Test. Mat. Proc. 38pt. 1: 318 1938.

Gives results of extensive series of tests; includes many stress-strain curves; shows influence of different factors on strength and stress-strain characteristics.

Ab38. Morey, G. W.
"Properties of Glass," Reinhold Pub. Co. 561pp 1938.

Ab28. Gonnerman, H. F., and Shuman, E. C.
"Compression, Flexure and Tension Tests of Plain Concrete,"
Am. Soc. Test. Mat. Proc. pt. 2 28: 527-564 1928.

"The investigation described in this paper was made for the purpose of determining the effect on the flexural and tensile strength of plain concrete of some of the factors which are known to influence the compressive strength."

Ac. STATIC TEST CHARACTERISTICS---UNREINFORCED MASONRY STRUCTURAL ELEMENTS

See also: Af49 "Chalmers Tekniska---", Aa43 Plummer, Aa50 Plummer

Ac48. Feret, L., and Caen, F.
"Mechanical Resistance of Masonry," (In French) *Institut Technique du Bâtiment et des Travaux Publics Cir Serie I* n.37, Oct. 5, 1947 (19 pp).

Study of causes of failure of various types of structures; influence of joints studied by tests, wall elements with high mechanical resistance connected with poor mortar render resistance greater than that of mortar; influence of type of mortar.

Ac48. "Dry Block Panel Shot with Jet-Crete," Construction Methods v.30 n.6 pp.96-8 June 1948.

Description of dry laid concrete blocks, sandwiched between two layers of Jet-Crete (air-applied concrete), tested in bending.

Ac47. "Cracking Tendencies in Brick or Stone Masonry Walls at the Structural Slab," Am.Conc.Inst.J. 18:606-8 Jan.1947.

Ac43. "Breathing Walls of Brick and Tile, A New Masonry Conception," Brick and Clay Rec. 102:14-16 April 1943.

Ac43. Sweet, H.A.
"Resistance of Brick Walls to Wind," Engr. News Rec. 131:630-1 p.21, 1943. Discussion: 131:734-5; 132:22, 318-19; 133:22.

Ac42. Molloy, E.
"Brickwork and Masonry," Chemical Pub.Co. 140pp. 1942.

Ac41. "Testing New Masonry Units, National Bureau of Standards," Rock Prod. 44-70 June 1941.

Ac38. Whittemore, H.L., and Stang, A.H.
"Methods of Determining the Structural Properties of Low-Cost House Construction," Building Materials and Structures Report No.2 (BMS 2), Bureau of Standards, 1938.

Report gives complete instructions concerning the procedure to be used in testing walls, partitions, floors and roofs in the series of tests to follow. Loading types to be used: compression, transverse, concentrated load, impact load, and racking loads.

Ac38. Whittemore, Stang, and Parsons
"Structural Properties of Six Masonry Wall Construction," BMS 5 Bur. Stand. 1938.

Report of tests made on walls by procedure given in BMS 2. Walls were of brick, clay tile, and concrete block. Report gives complete data on different types of loads and corresponding typical failure features. Several load-deflection curves.

Ac34. Conner, C. C.
"Resultant Separation Cracking Between Various Mortars and Brick in Existing Brick Structures," Am. Soc. Test. Mat. v. 34 pt. 2 1934.

Ac32. Richart, Moorman, Woodworth
"Strength and Stability of Concrete Masonry Walls," Univ. of Ill. Bul. No. 89, July 5, 1932.

Test results on: types of mortar, design of units, deformations of axially-loaded walls, walls under eccentric loading; flexural strength of walls.

Ac31. Kelch, Norman W.
"Methods Used in Testing Masonry Specimens for Bending, Tension, and Shear," Am. Ceramic Soc. J. v. 14 Feb. 1931.

Gives results of testing of 24 walls, 4.5 ft. wide, 5.5 ft. high, some 8 inches and some 12 inches thick. It was shown that aging of lime mortar is essential. Brick masonry withstands earthquake shocks when mortar is matured by ageing.

Ac28. McBurney, J. W.
"Effect of Strength of Brick on Compressive Strength of Brick Masonry," Am. Soc. Test. Mat. Proc. 28pt. 2:605-634 1928.

Data presented on tests of 186 brick walls with different makes of brick, methods of testing; tables of comp. strength.

[illegible] Whittemore and Stang
"Compressive Strengths of Sand-Lime Brick Walls," Bur. Stand. Tech. Paper n. 276 v. 19, 1924-25.

Also gives some results of tensile tests.

Ac24. Ingberg, S. H.
"Factors Affecting Brick Masonry Strength," Am. Soc. Test. Mat. Proc. 24pt. 2:909-919 1924.

Description of brick masonry, test methods and effects, strength properties of individual bricks, compressive strength of masonry, ratio of masonry strength to brick strength.

Ac16. Kreuger, H.
"The Strength of Brick Masonry," (In German) *Tonindustrie Zeitung* 40:597-633 1916.

Ad. STATIC TEST PROPERTIES---REINFORCED CONCRETE STRUCTURAL ELEMENTS

Ad50. Mendenhall, John D.
"Diaphragms of Reinforced Concrete," paper presented at National Spring Meeting of Am. Soc. Civil Engrs., Los Angeles, April 1950.

Analysis of concrete shear wall: analyzed by five comparative methods. Elastic stability investigated. Cal. Div. of Arch. allowable stresses. Analysis of floor of ten-story building. Influence of construction joints and slab anchorage.

Ad48. Holmberg, A.
"Cracks in Lower Part of Concrete Wall," (In Swedish) *Betong v. 33 n. 3, pp. 144-9 1948.*

Development of equations which give critical length of wall and maximum strain; computation of reinforcement required to avoid cracks.

Ad30. Parsons, D.A., and Stang, A.H.
"Tests of Composite Beams and Slabs of Hollow Tile and Concrete," Bur. Stand. J. Research v. 4 Research Paper n. 181 June 1930.

Ad25. Parsons and Stang
"Tests of Hollow Tile and Concrete Slabs Reinforced in One Direction," Bur. Stand. Tech. Paper No. 291.

Ae. STATIC TEST CHARACTERISTICS---REINFORCED MASONRY STRUCTURAL ELEMENTS

Ae46. Converse, Frederick J.
"Tests on Reinforced Concrete Masonry," Bldg. Stand. Monthly Feb. 1946. (Reinforced Brick Masonry)

Tests made of wall panels in flexure, core beams in flexure, and wall panels in racking or shear. Conclusions: walls behaved under test according to principles of reinforced concrete design. (All test specimens were of reinforced brick masonry.) Much specific test data and curves given.

Ae45. Pippard, A. J. S.
"The Approximate Estimation of Safe Loads on Masonry Bridges," Symposium of papers on wartime engr. problems, Inst. Civ. Engrs. 1945.

Calculations and analyses of arch bridges and other types, considering different variables and solving for tensile and compressive strengths of the elements of the bridge; as well as thrusts and reactions of other elements. The ability of mortar to take some tensile stresses is adhered to in this analysis.

Ae42. "Reinforced Brick Masonry Passes First Real Test in California Earthquake," Brick and Clay Rec. 100:34-36, Feb. 1942.

Ae38. Vaugh, M.
"Reinforced Brickwork," Univ. of Missouri Engr. Exp. Sta. Bul. vol. 29, n. 37, 1938.

Ae35. Gallagher, E. F.
"Bond Between Reinforcing Steel and Brick Masonry," Brick and Clay Rec. 86:92 Mar. 1935.

Ae35. Vaugh, M. and Mosher, A.
"Record of Reinforced Brickwork in Indian Earthquake," Engr. News Rec. 115:738-9 Nov. 28, 1935.

Little damage to properly designed bldgs. Weaknesses in ordinary brick buildings are as follows: Use of arches, which can not withstand lateral forces; bldg. offers little resistance to twisting; vertical walls varied in damage with type of mortar used more than with any other observed factor; not tying parts of bldgs. together---applies especially to walls and ceilings. Little difference in damage sustained by reinforced brickwork and reinforced concrete.

Ae34. Lyse, Inge
"Tests of Reinforced Brick Columns," Lehigh Univ. Pub. No. 6, June 1934.

Ae34. Withey, M.O.
"Tests on Reinforced Brick Masonry Columns," Am. Soc. Test. Mat. Proc. pt. 2 34:387-405 1934.

"The results indicate that the column strength varies directly with the strength of the masonry and the percentage of longitudinal steel, and is increased by the use of lateral reinforcement. Strengths of 5000 psi based on gross area and over 7000 psi on the cores after shell spalling were attained."

Ae33. Hansen, James H.
"Developments in Reinforced Brick Masonry," Am. Soc. Civ. Engrs. Proc. pt. 1 59:407-427 1933.

"This paper contains a brief history of the development of reinforced brick masonry to the time that engineers in the U.S. became interested in the subject. Its development is then given in detail by analysis of tests."

Ae33. McBurney, J. W.
"Discussion of 'Development in Reinforced Brick Masonry'," Am. Soc. Civ. Engrs. Proc. 59:1344, 1933.

Ae33. Withey, M.O.
"Tests on Brick Masonry Beams," Am. Soc. Test. Mat. Proc. 33pt. 2:651-669, 1933.

Making and testing of brick masonry beams. Proof of validity of using reinforced concrete design procedure for design of reinforced brick masonry beams.

Ae32. Parsons, Stang, and McBurney
"Shear Tests of Reinforced Brick Masonry Beams," Bur. Stand. J. Research 9:749 1932 (Research Paper 504).

Description of specimens and testing methods; results of beams tests: deformations in beams, positions of neutral axis; load-deflection curves, etc.

Ae32. "Report of Committee on Reinforced Brick Masonry," Nat. Brick Mfgrs. Assoc. Research Fndn., Reports 3, 4, 5, and 6. 1932.

Ae32. Whittemore and Dear
"An Investigation of the Performance Characteristics of Reinforced Brick Masonry Slabs," Va. Poly. Inst. Bul. No. 9 June 1932.

Extensive series of tests run on reinforced brick masonry slabs. Gives test results including strength of brick and mortar used, absorption of brick, load deflection curves, moment vs strain curves, measured vs calculated stresses; lists factors affecting strength of reinforced brickwork. A comparison of the performance characteristics of reinforced brick masonry slabs and reinforced concrete slabs.

Ae31. Lent, L.B.
"Reinforced Brick Masonry," Am. Ceramic Soc. J. 14:469-481, 1931.

A descriptive presentation of the practical use of reinforced brick masonry is given together with a historical survey of the development of its use.

Ae23. Brebner, A.
"Notes on Reinforced Brickwork," Govt. of India, Public Works Dept. (Calcutta), Tech. Paper No. 38, 1923.

Af. STATIC TEST CHARACTERISTICS---MASONRY CONSTRUCTION PRACTICES

See also: Aa50 Plummer, Aa43 Plummer

Af51. Shield, John E.
"Reinforced grouted brick masonry provides wall resistant to lateral forces and to damage by fire."

Pamphlet, South West Builder and Contractor, for Brick Manufacturers Assoc. of Southern California. April 27, 1951.

Af50. "Building Code Requirements for Reinforced Masonry," Concrete Masonry Manufacturers Assoc., 3160 West 6th St., L.A. 5, California, 21pp, Aug. 1, 1950.

Af50. Kelch, Norman W.
"Some Properties of Reinforced Grouted Brick Masonry," Am. Soc. Test. Mat. Bul. No. 168, Sept. 1950.

Article gives basis for design of reinforced grouted brick masonry in Southern California; excerpts from building codes with working stresses; description of construction practice; and results of recent tests on mortar, grout, and brick assemblies.

Af50. "Building Construction Code of New York City, 1950"

The code states that the individual cementing agents (quicklime, hydrated lime, portland cement) must meet the appropriate ASTM specifications.

Specifications for mortar proportions are as follows: Lime mortar, one part lime putty or hydrated lime and maximum of three parts of sand; cement lime mortar, one part lime putty, one part cement, maximum of six parts of sand; cement mortar, one part cement and maximum of three parts of sand and almost 15% of cement content can be hydrated lime or lime putty.

Tensile strength must be at least 150 psi at age of 28 days by standard test.

Masonry units must be tested according to proper ASTM specifications for given type of unit.

No specifications are given for brick reinforcement.

Af50. Building Officials Conference of America
"Basic Building Code, 1950".

Gives essentially same material in regard to masonry as that given by the New York Building Construction Code---See Af50 above.

Af49. Kelch, Norman W.
"Design and Construction of Reinforced Grouted Brick Masonry and some Properties Relating thereto," Paper prepared for presentation at 1st Pac. Area National meeting of Am.Soc.Test.Mat., San Francisco, Calif., Oct. 1949.

Af49. *"Chalmers Tekniska Hogskolas Handlingar," No. 84, Gothenburg, Sweden, 1949.*

Gives ultimate stresses in masonry elements and mortar; data on flexure tests of masonry materials, some standards from different countries on allowable and ultimate stresses. English summary and bibliography with 52 references included.

Af47. Wailes, C.D., Jr.
"Reinforced Concrete Masonry Design," Concrete 55:23-5, December 28, 1947.

Shows typical placement of reinforcement in construction of walls for small houses, connection of wall and roof.

Af47. "How to Construct Walls of Reinforced Brick Masonry," Brick and Clay Rec. 110:35-39, April 1947.

Information given and wall sections shown in diagram may be used as a guide for small installations of reinforced brick masonry.

Af46. Griffith, J.R.
"Construction Design Chart," Western Constr. News 21:105, Nov. 1946.

Design chart to determine flexural strength of reinforced brick masonry beams with balanced tensile reinforcing. Nomograph for design of reinforced brick masonry beams.

Af45. Bowen, F.M.
"Design Tables and Graphs for Reinforced Brickwork," Surveyor v.104 n.2764 Jan.12,1945. (Also: No. 2765 pp. 31-3, Jan. 19,1945.)

Review of British Standard 1146-1943 which specifies that fundamentals of design and analysis of reinforced concrete should form basis of brickwork standards; table gives sizes of steel needed, economical design constants for reinforced beams and slabs and permissible loads for axial and eccentric loads on columns.

Af45. "Steeltyd Reinforced Grouted Brick Masonry Design," Davidson Brick Company, 4701 Floral Drive, Los Angeles 22, Calif., c1945.

Design of walls, columns, bond beams, footings; rectangular beams; anchorage of joists to walls; bending and direct stress of columns; horizontal trusses; distribution of lateral loads to shear walls; general tests, inspection and calculations.

Af44. "American Standard Building Requirements --- Masonry," American Standards Assn. A41.1, 34pp., 1944. (See also: Indus. Standardization v.15 n.3, 1944, p.3709; Cer.Age, v.44 n.1, July 1944, pp.26-7.)

Af31. "Modifications in Recommended Minimum Requirements for Masonry Wall Construction," Building Code Committee of Dept. of Commerce (Supt. of Documents, Govt. Printing Office, Washington, D.C.) 1931.

Amendment to "Recommended Minimum Requirements for Masonry Wall Construction," prepared in 1924 by same Committee. (See Af24.)

Af29. Lent, L.B.
"Possibilities for Reinforced Brickwork," Engr.News Rec. Feb. 21, 1929 pp. 304-306.

Includes a survey of practice and tests in India, where such construction has been used for floors, roofs, stairways, bridge decks, lintels, and cornices.

Af24. "Recommended Minimum Requirements for Masonry Wall Construction," Building Code Committee, Dept. of Commerce (Supt. of Documents, Govt. Printing Office) 1924.

Appendix contains an extensive bibliography of tests of masonry. See Af31.

Af?? "Handbook of Building Regulations - Making of Building Laws" (Danish).

Gives specifications for reinforcement in reinforced cn concrete firewall.
"The Building Commission does not consider lime mortar as responsibly prepared if it does not contain at least 7½% chalk hydrate. Carbide lime is not allowed for use."

Ba. DYNAMIC TEST CHARACTERISTICS---BRICKS, CONCRETE BLOCKS

No references in this section.

Bb. DYNAMIC TEST CHARACTERISTICS---PLAIN CONCRETE, MORTAR, GLASS

Bb49. Watstein, D.
"Investigation of Properties of Plain Concrete Under Impact," Building Technology Div. Bur. Stand., Washington, D.C., 1949. (Available on micro-film also)

Summary of Results: The impact tests made on 1 1/2 by 6 in. cylinders covered a range in rates of straining from 10^{-6} in./in second to 0.8 in./in per second, with the lowest rate corresponding to static tests. The average static strength was 6570 psi. The dynamic specimens were tested in three series of tests designated as series A, B, and C. The duration of impact in these three series were, respectively: 0.78, 0.0112, and 0.0025 seconds, with the corresponding rates of straining being; respectively, 0.002, 0.148 and 0.81 in./in per second. Results show that the compressive strength of concrete increased only slightly for rates of straining up to about 0.1 in/in per second. Further increase in the rate of straining to 0.8 in/in/sec (Test C) was accompanied by an increase in the compressive strength of 48% as compared with the static strength of 1 1/2 by 6 in. specimens. The dynamic secant modulus of elasticity, however, increased roughly to the same extent over the static value for all rates of straining; the ratios of the dynamic to static moduli were 1.18, 1.25 and 1.21 for series A, B and C respectively. Test A gave dynamic strength of 9.5% greater than the static strength of 6570 psi, while Test B gave same dynamic increase in strength (9.0%). The static E was about 4.11 x 10^{6} A later series of tests (F) made on 3 by 6 in. cylinders gave the following results: Dynamic strength 45% greater than static strength, dynamic E about 16% greater than the static (secant) E. The rate of straining in test F was considerably greater than for the tests A, B and C.

Bb43. Nutting, P.G.
"General Stress-Strain-Time Formula," Franklin Inst. J. v. 235 n. 5 pp. 513-24, May 1943.

"Detailed discussion of general law of deformation advanced by author, which is relation between stress, strain, time and constant (a) representing ease of yielding to stress or deformability; formula developed covers whole range from elastic solids to viscous liquids and has found favor in research on paints, plastics, asphalts, and food products." Bibliography.

Bb42. Evans, R.H.
"Effect of Rate of Loading on Mechanical Properties of Some Materials," Instn. Civ. Engrs. J. v.18 n.7 and 8, June 1942, pp.296-306 and Oct. pp. 563-7.

Study of effect of rate of loading upon crushing strength of rich and lean mixes of concrete, and yield point, ultimate or tensile strength, % elongation, and reduction of area of mild steel.

Bb41. Obert, L., and Duvall, W.I.
"Discussion of Dynamic Methods of Testing Concrete with Suggestions for Standardization," Am. Soc. Test. Mat. Proc. 41:1053-1071 1941.

"To assist in standardizing the dynamic methods of testing concrete, the underlying theory, apparatus, effects of moisture, and size of specimen have been studied and the findings presented herein."

Bb36. Jones, P.G., and Richart, F.E.
"The Effect of Testing Speed on Strength and Elastic Properties of Concrete," Am. Soc. Test. Mat. Proc. 36pt. 2: 380-392, 1936.

Description of tests run on 6 by 12 in. cylinders. Test results: stress-strain curves, relation between strength and rate of loading, creep of concrete during test, secant and tangent moduli.

Bb35. Preston, F.W.
"Time Factor in the Testing of Glassware," (Observations by G.A. McKee), J.Am. Ceramic Soc. 18:220 1935.

Bc. DYNAMIC TEST CHARACTERISTICS---UNREINFORCED MASONRY STRUCTURAL ELEMENTS

See also: Ac38 Whittemore, Ac38 Parsons

Bd. DYNAMIC TEST PROPERTIES---REINFORCED CONCRETE STRUCTURAL ELEMENTS

See also: Dc35 Glanville, Dc32 Fox

Bd50. Ofjord, Wells, and Others
"Behavior of Structural Elements Under Impulsive Loads," a report submitted by MIT to New England Div., Corps of Engrs., Dept. of the Army, in completion of contract no. W-19-016-engr.-3215. 126pp. April 1950.

"This report presents a description of the experimental techniques, the results, and the conclusions from a series of laboratory investigations on the behavior of reinforced concrete beams and one way slabs and all steel beams subjected to static or impulsive loads, and the preliminary study of the behavior of plain and reinforced concrete shear walls under the action of static loads."

Bd50. Penzien, Joseph, and Ofjord, A.
"Resistance of Impulsively Loaded Reinforced Concrete Beams," Informal Interim Report #2, MIT to New England District, Corps of Engrs., Contract W-19-016-engr.-3215 1950.

Bd49. Hansen, R.J., and Wilbur, J.B.
"Behavior of Reinforced Concrete Structural Elements Under Long Duration Impulsive Loads," report submitted to New England Div., Corps of Engrs., 1949.

Part I, Summary Report: Outline of investigation; objectives for different phases of program.
Part II: "Behavior within the Elastic Range": The principal conclusion reached from the study of beams loaded statically and impulsively in the elastic range of behavior is that the elastic dynamic theory is applicable for predicting the elastic behavior of structural elements subjected to impulsive loading conditions.
Part III: "Behavior within the Plastic Range": Among the number of conclusions drawn from the investigations are the following: Within the plastic range, simple beams are stronger when subjected to impulsive loads than they are under static loads of equal magnitude.---The upper limit of the plastic range is reached when the permanent central deflection is approx. equal to 1/32 of the span length of the beam.---Over-reinforced beams appear to have no plastic range; they fail suddenly and completely---For a certain range of dynamic rate of straining, the stress-strain curve over the first 3% strain, is raised approx. 40% over the static values.---

If the duration of the load is greater than a time approx. equal to the fundamental period of vibration of the beam, the effect of increasing the duration of the load is negligible on causing additional damage to the beam.
Part IV: "Design, Construction and Operation of Slab Machine". (An insufficient number of tests have been run so far to permit the drawing of any general conclusions regarding the behavior of slabs under impulsive loads. These results should be forthcoming in the next few months.)

Bd48. Hansen, R. J.
"Controlled Impulsive-Load Testing Machine," Exp. Stress Anal. Soc. Proc. v. 6 n. 2 pp. 64-67, 1948.

Bd48. Hansen, R. J.
"Long Duration Impulsive Loading of Simple Beams," Bost. Soc. Civ. Engrs. J. v. 35 n. 3 pp. 272-285, July 1948.

Bd48. Hansen, R. J., Penzien, J., Steyn, K., and Wilbur, J. B.
"Behavior of Reinforced Concrete Beams Under Long Duration Impulsive Loads," report submitted to Engr. Research and Development Labs., Fort Belvoir, Va.

Presents the results of lab investigation of 142 reinf. conc. beams made to determine their structural behavior under the action of impulsive loads. Describes rapid load machine and test procedures and results. "The primary purpose of the investigation undertaken by the MIT has been to determine the permissible design stresses for use in the design of structures to resist blast waves of about 0.5 seconds duration.---"

Bd45. Simms, L. G.
"Actual and Estimated Impact Resistance of Some Reinforced Concrete Units Failing in Bending," Inst. Civ. Engrs. J. n. 4 v. 23 pp. 163-179, Feb. 1945.

Tests to destruction of slabs and of simple beams designed to fail in bending. Tests on mild steel reinforcement. Impact tests performed by means of a falling mass. Tests show the limits of deformation in bending of some simple reinf. conc. beams and slabs occurring after the steel had yielded or after the conc. had crushed. The form of damage was roughly the same under either static loading or impact. The damage due to impact was reasonably predicted from considerations of energy absorbed under static loading, used in conjunction with a simple energy equation, in which a reduction factor had been derived from considerations of an elastic material.

Bd44. Munse, W.H., and Richart, F.E.
"Impact Tests of Reinforced Concrete Beams, III," NDRC Report no. A-304 (OSRD no.4490) 1944.

Effects of size of bearing plateand repetition of loading, span length. The change in static characteristics of a beam due to impact loading was found to be a good measure of the damage; beams weaker in repeated impact loading than in a single impact loading; strength of concrete not an important factor in beams with adequate web reinforcement.

Bd44. Wilbur, J.B.
"Permissible Stresses for Use in Design Based on Elastic Analysis of Reinforced Concrete Beams Acted upon by Impulsive Loads," Informal Progress Report No.23, Engr. Studies of Principles of Design of Fortifications and Other Structures. (MIT) 1944.

Bd44. Wilbur, J.B.
"Revised Procedure for Designing Roof Slabs to Resist Bombing," MIT Informal Progress Report No. 24, 1944.

Bd43. Kluge, R.W.
"Impact Resistance of Reinforced Concrete Slabs," Am.Conc.Inst.J.14:397-412 April 1943.

A report of the tests conducted at the Bur.Stand for the Maritime Comm. The primary purpose of the tests was to compare the behavior under impact load, of slabs with and without supplementary reinforcement in the form of overlapping spirals. Describes apparatus and tests, deflection curves. 16pp.

Bd43. Newmark, N.M., and Richart, F.E.
"Impact Tests of Reinforced Concrete Beams,II," NDRC Report No.A-213 (OSRD No. 1751).

Description, results, and conclusions of tests made on the effects of web reinforcement, longitudinal steel, strength of concrete and horizontal construction joints under impact loading. Web reinforcement found more important than longitudinal steel in impact---grade and amount of steel unimportant. Conc. strengths unimportant except under great impacts. Construction joints or scabbing planes unimportant.

Bd43. Wilbur, John B.
"The Analysis of Elastic Structures Acted upon by Impulsive Loadings," NDRC Report No. A-219, OSRD No.1915.

Analysis of beams, one-way slabs, continuous beams, two-

way slabs; general theory of the effect of impulsive loadings as applied to flexural members; quantitative treatment; bibliography.

Bd42. Robertson, H.P., and Slutz, R.J.
"The Reactions of Thin Beams and Slabs to Impact Loads, Part I, General Theory; Part II, Beams," National Research Council, Comm. on Passive Protection against Bombing, Interim Report Nos. 13 and 14.

Bd42. Richart, F.E., and Newmark, N.M.
"Impact Tests of Reinforced Concrete Beams," NDRC Report No. A-125 (OSRD No. 1105).

Description of testing equipment used for static and impact load tests on beams; intermediate and high grade steel as effective as structural grade steel in concrete subject to impact. For low velocity impacts and low energy, beams act as if statically loaded. For low velocity, high energy less difference between steel types. For high velocity, diagonal tension failure.

Be. DYNAMIC TEST CHARACTERISTICS---REINFORCED MASONRY STRUCTURAL ELEMENTS

No references in this section.

Bf. DYNAMIC TEST PROPERTIES---METALS

Bf50. Hansen, R.J., and Others
"Behavior of Structural Elements under Impulsive Load," MIT report to Corps of Engrs. (Final) Part I, April 1950, Part II, Nov. 1950.

Bf50. Homes, G., and Gouzou, J.
"On the Mechanism of Metallic Fracture," (From "*Revue de Metallurgie*," v. 47, n. 8, Sept. 1950, pp. 678-69[illegible]). Review in Engr's Digest v.XII, n.2, pp.40-44, Feb. 1951.

"The present article describes preliminary, purely experimental, investigations into the mechanism of fracture in simple tension of small standard flat test specimens of zinc and mild steel."

Bf49. Bucklin, Grant
"The Extrapolation of Short Time Stress Rupture Data," Navy Bur. Ships RM3-49 Oct. 1949.

Bf49. Kramer, E.H., and Lunney, E.J.
"Dynamic Measurements during Aircraft Landings," Soc. Exp. Stress Anal. Proc. v. 7, n. 1, pp. 83-102, 1949.

Dynamic loads during landing impact. Accelerations, landing gear loads, rate of descent, tire and strut deflection. Six widely different aircraft types.

Bf49. Shanley, F.R.
"Analysis of Stress-Strain-Time Relations from the Engineering Viewpoint," (Preprint of paper to be presented at the second Symposium on Plasticity, Brown Univ., April 4-6, 1949).

"Stress-Strain diagrams for various loading histories are developed by a step-by-step process in which elastic action is assumed to be instantaneous and reversible, while plastic action is assumed to occur at constant stress, as a function of stress, time, and the extent of plastic straining."

Bf48. Clark and Wood
"The Influence of Rapid Load and Time at Load on the Tensile Properties of Several Alloys," CIT report to AAF Air Material Command, Contract W33-038-ac-14102 (15773) June 30, 1948.

Bf48. Clark, D. S., and Duwez, P. E.
"Discussion of the Forces Acting in Tension Impact Tests of Materials," J. App. Mech. v. 15, n. 3, pp. 243-247, Sept. 1948.

"A method of measuring the forces acting on a specimen during a tension impact test is described briefly in this paper." Part of conclusions: "The principles of the propagation of plastic strain provide a clear interpretation of the force measurements obtained with a dynamometer in tension impact testing." Gives stress-strain and other diagrams. Bibliography.

Bf48. Thornton, D. L.
"Impact Loading of Structures," Engr. v. 165, n. 4292, pp. 409-412, April 30, 1948.

Applications occur in guns, ships and fortifications subject to effects of explosion or impact, in dams and other structures in seismic regions, and in development of metals for forming; two formulas given with which in rapid loading of structural system of given type, measure of damage or intensity is best expressed; these formulas are mutually consistent; (1) implies knowledge of amplitude, while (2) implies knowledge of time involved in action.

Bf48. White, M.P.
"The Dynamic Stress-Strain Relation of a Metal with a Well-defined Yield Point," 7th Int. Concr. Appl. Mech. Proc. pt. 1 pp. 329-343, 1948.

Bf47. Sachs, G., Zener, C., Dorn, J.E., and Others
"Fracturing of Metals," 311pp. Published by Am. Soc. for Metals, Cleveland, Ohio, 1947.

A seminar on the fracturing of metals. Following gives titles of typical subjects treated: "The Micro-Mechanism of Fracture," "The Effect of Stress State on the Fracture Strength of Metals," "Effect of Strain on Fracture." Includes 14 other similar articles. Bibliographies.

Bf47. Stepler, Paul R.
"Explosive Impact Tests," Soc. for Exp. Stress Anal. Proc. v. V, n. 1, pp. 1-25, 1947.

"The research that will be presented in this paper is concerned with the comparison of materials under high speed tensile impact with static tensile conditions." One of conclusions is that for all the materials tested, strength increased with the strain rate. Important tests, gives curves; shows equipment used. Extensive bibliography.

Bf46. Windenburg, D.F.
"Significance of Impact-Test Dat... Design of Engineering Structures," Product Engr. 17:81-3 Sept. 1946.

Charpy impact test curve (impact energy vs temperature). Discussion of ductility of metals and the effect of temp. on impact sensitivity, transition temps of metals, tests at low temp. Conclusion: materials used under tensile loading, especially at low temp., should be given impact test.

Bf44. Bridgman, P.W.
"Plastic Properties of Steel Under Large Strains and High Stresses, Final Report," NDRC Report No. A-294, OSRD 4256. Oct. 1944.

Bf43. Dohrenwend, C.O., and Mehaffey, W.R.
"Dynamic Loading in Design," Mach. Design 15:99-104, June, 1943.

Contains good bibliography.

Bf43. Seitz, Frederick
"The Testing of Metals in Compression at High Rates of Strain," NDRC No. A-174 OSRD 1388.

Bf42. Seitz, Frederick, Jr., Lawson, Andrew W., and Miller, Park
"The Plastic Properties of Metals at High Rates of Strain," OSRD 495, April 8, 1942.

Bf39. Murphy, Glenn
"Stress-Strain-Time Characteristics of Materials," Am. Soc. Test. Mat. Bull. No. 101, pp. 19-22, Dec. 1939.

Ca. BLAST LOADING---PROPAGATION AND DECAY OF BLAST WAVES

Ca51. Makino
"The K-B Theory of the Propagation of Spherical Shock Waves and its Comparison with Experiment," BRL-750, Apr.1,1951.

Ca50. Davies, R.M., and Taylor, G.
"Vertical Velocity of a Large Bubble when Change from a Very Light to Heavy Fluid is Discontinuous," Royal Soc. Proc.Series A v.200,n.375, 1950.

Ca50. Edmonson
"Normal Coupling Conditions Between Detonation Waves in High Explosives and Shock Waves," File no. APL-BBW-192 June 1950.

Ca50. "The Effects of Atomic Weapons," U.S.Dept. of Defense and AEC.

"Purpose of book is to present, as accurately as is possible in the light of present knowledge, a technical summary of the results to be expected from the detonation of atomic weapons."
Gives analytical treatment of air, ground and underground and underwater atomic bomb bursts; shows pictures of destruction in Japan, Bikini; treats radioactive effects, effects on personnel, protective measures.

Ca50. Pike
"Mechanism of Detonation," Nature 165:214, 1950.

Ca50. von Neumann and Richtmyer
"A Method for the numerical Calculation of Hydrodynamic Shocks," J. Appl.Physics 21:232, 1950.

Ca50. Payman, W., Shepherd, W.F.C.
"Explosions and Shock Waves," Ministry of Supply Advisory Council 735 Phys/Ex 98 (2-12-157) 1941.
Winckler Von Voorhis Panocky Landenburg HDRC Der 2 OSRD No.5204 1945.

Ca50. Taylor, Geoffrey
"The Formation of Blast Wave by a Very Intense Explosion," Royal Soc.Proc.v.201,n.1065,pp.158-174, Mar.1950.

Ca50. Taylor, Geoffrey
"The Formation of a Blast Wave by a Very Intense Explosion, II---The Atomic Explosion of 1945 in New Mexico," Royal Soc. Proc.v.291, n.1065,pp.175-186, Mar.1950.

Ca50. Westervelt, Peter J.
"The Mean Pressure and Velocity in a Plane Acoustic Wave in a Gas," J. Acoust.Soc.America v.22, 1950.

Ca49. Bond, J.W.
"Scaling of Peak Overpressure in a Non-uniform Atmosphere," (C-RD) SC 1949.

Ca49. Cowan, G.R., and Hornig, D.F.
"The Thickness of a Shock Front in a Gas," Phys.Rev. v.75 n.8 p.1294, Apr.15, 1949.

Ca49. Doring, W., and Burkhardt, G.
"Contributions to the Theory of Detonation," File Nos. ATI-77863, AEC-51-3-1988 May 1949.

Ca49. Eyring, Powell, Duffey and Parlin
"The Stability of Detonation," Chem.Rev.45:69 1949.

Ca49. Hess, R.V.
"Study of Unsteady Flow Disturbances of Large and Small Amplitudes Moving Through Supersonic or Subsonic Steady Flows," NACA TN 1878 May 1949.

Ca49. Huber, P.W., Fitton, C.E., and Delpino, F.
"Experimental Investigation of Moving Pressure Disturbances and Shock Waves and Correlation with One-Dimensional Unsteady Flow Theory," NACA TN 1903 July 1949.

Ca49. Pillow, A.F.
"The Formation and Growth of Shock Waves in the One Dimensional Motion of a Gas," Cambridge Philos.Soc.Proc. v.45 1949.

Ca48. Cassen, B., and Stanton, J.
"The Decay of Shock Waves," J. App.Physics v.19, n.9, pp.803-807 Sept.1948.

Ca48. Cole, R.H.
"Underwater Explosions," Princeton Univ.Press, 437pp. 1948.

Study of scaling laws.

Ca48. Courant, R., and Friedrichs, K.O.
"Supersonic Flow and Shock Waves," 464pp., Interscience Publishers, N.Y. 1948.

Ca48. Herpin
"Kinetic Theory of a Shock Wave," Rev.Sci.Laris 86:35 1948.

Ca48. Stoner and Bleakney
"Attenuation of Spherical Shock Waves in Air," J. Appl. Ph. 19:670, 1948.

Ca47. Brinkley and Kirkwood
"Theory of the Propagation of Shock Waves from Infinite Cylinders of Explosive," Phys. Rev. 72:1109, 1947.

Ca47. Brinkley and Kirkwood
"Theory of the Propagation of Shock Waves," Phys. Rev. 71:606, 1947.

Ca47. Brinkley and Kirkwood
"Theory of the Propagation of Shock Waves from Cylindrical Charges," Phys. Rev. 72:119, 1947.

Ca47. Courant
"Formation and Decay of Shock Waves," File No. IMM-NYU-158 May 1947.

Ca47. Courant
"Decay Shocks," File No. IMM-NYU-167 Oct. 1947.

Ca47. Herpin
"The Physics of Shock Waves - I," Rev. Sci. Paris 85:817, 1947.

Ca47. Liepmann and Puckett
"Aerodynamics of a Compressible Fluid," Wiley, 1947.

Ca47. Martin, Monroe H.
"A Problem in the Propagation of Shock," App. Math. Quarterly, v. IV p. 370, Jan. 1947.

Ca47. Yung-Huai Kuo
"The Propagation of a Spherical Cylindrical Wave of Finite Amplitude and the Production of Shock Waves," App. Math. Quarterly v. IV, p. 349, Jan. 1947.

Ca46. Dumond, Cohen, Panofsky, and Deeds
"Determination of the Wave Forms and Laws of Propagation and Dissipation of Ballistic Shock Waves," Acous. Soc. Am. J. 18:97, 1946.

Ca46. Grime and Sheard
"An Experimental Study of the Blast from Bombs and Bare Charges," Roy. Soc. Proc. A187:357, 1946.

Ca46. Jost, W.
"Explosion and Combustion Processes in Gases," p. 168 McGraw Hill, 1946.

Ca46. Sachs, R.G.
"Some Properties of Very Intense Shock Waves," Phys. Rev. 69:514, 1946.

Ca46. Taylor, G.I.
"The Air Wave Surrounding an Expanding Sphere," Roy. Soc. Proc. Ser. A, v. 186 n. 1006, pp. 273-292, Sept. 1946.

Ca45. Bethe, H.A., and Teller, E.
"Deviations from Thermal Equilibrium in Shock Waves," BRL Rep. X-117, Aberdeen, Md., 1945.

Ca45. Brinkley and Kirkwood
"The Blast Wave in Air Produced by Line Charges," OSRD-5659 Oct. 1945.

Ca45. Brinkley and Kirkwood
"Tables and Graphs of the Theoretical Peak Pressures, Energies, and Positive Impulses of Blast Waves in Air," OSRD-5137, May 1945.

Ca45. de Haller, P.
"On a Graphical Method of Gas Dynamics," *Technische Rundschau Sulzer, n. 1, p. 6, 1945. R. T. P. Trans. No. 2555.*

Ca45. Kirkwood and Brinkley
"Theoretical Blast Wave Curves for Cast TNT," OSRD-5481, Aug. 1945.

Ca45. Kirkwood and Brinkley
"Theory of the Propagation of Shock Waves from Explosive Sources in Air and Water," OSRD-4814, Mar. 1945.

Ca45. Stettbacher, A.
"Gas and Dust Explosions," Arch. Agnew Wiss. Tech. 11:325, 1945.

Ca45. Stoner
"The Pressure Distance Relation for TNT determined by Measurement of Shock Velocity," OSRD-6637, Mar. 1945.

Ca44. Sachs
"Ambient Pressure and Temperature," BRL-466, Aberdeen, May 1944 (Ballistics Research Lab.)

Ca44. Thomas
"Note on Becker's Theory of the Shock Front," Chem. Phy. J. 12:449, 1944.

Ca43. Chandrasekhar, S.
"On the Decay of Plane Shock Waves," File No. BRL-423, Nov. 1943.

Ca43. Von Neumann, J.
"Progress Report on Theory of Shock Waves," OSRD Rpt. 1140, 1943.

Ca43. "Shadowgraph Determination of Shock-Wave Strength," BuOrd Explosives Research Rpt. n. 11 Navy Dept. Bu. Ord., Washington, D.C. 25, Oct. 1943.

Ca41. Pfriem, H.
"The Two Dimensional, Undamped Pressure Wave of Large Amplitude," *Forschung, v. 12 n. 1, p. 51 Jan-Feb 1941.* RTP Trans. 2232.

Ca22. Becker, R.
"Shock Waves and Detonation," Ph. 8:321, 1921. (In German).

Ca22. Becker, R.
"Physical Characteristics of Solid and Gaseous Explosives," *Zeits f techn Physik v. 3, p. 152, 1922* (In German)

Ca22. Love, A.E.H., and Pidduck, F.B.
"On Lagrange's Ballistic Problem," Phil. Trans. Roy. Soc. London Ser. A, v. 222:167, Mar. 1922.

Ca1899. Vieille, P.
"On the Discontinuities Produced by the Sudden Release of Compressed Gas," (In French) *Comptes Rendus 129: 1228, 1899.*

Cb. BLAST LOADING---REFLECTION AND DIFFRACTION OF BLAST WAVES ON STRUCTURES

Cb51. Bleakney, Griffith, Weimer, Brickl
"The Effect of Reynolds Number on the Diffraction of a Shock Wave," File No. PU-TR-[illegible]-8.

Cb51. Duff and Hollyer
"Growth of the Turbulent Region at the Leading Edge of Rectangular Obstacles in Shock Wave Diffraction," File No. UMM-51-2, Jan. 1951.

Cb50. Bleakney
"The Diffraction of a Shock Wave Around a Hollow Block Opening Facing Shock," File No. PU-Q-5.

Cb50. Bleakney
"The Diffraction of Shock Waves Around Obstacles and the Transient Loading of Structures," Tech. Rpt. II-3, Princeton Univ. Dept. of Phys. Mar. 16, 1950.

Cb50. Bleakney, White, and Griffith
"Measurements of Diffraction of Shock Waves and Resulting Loading of Structures," J. App. Mech. p. 439, Dec. 1950.

Cb50. Duff and Hollyer
"The Effect of Wall Boundary Layer on the Diffraction of Shock Waves Around Cylindrical and Rectangular Obstacles," File No. UM-R-50-2, June 21, 1950.

Cb50. Duff and Hollyer
"The Diffraction of Shock Waves Through Obstacles with Various Openings in their Front and Back Surfaces," File No. UM-50-3, Dec. 7, 1950.

Cb50. Fletcher, Weimer and Bleakney
"Pressure Behind a Shock Wave Diffracted through a Small Angle," Phy. Rev. 78:634, 1950.

Cb50. Lighthill, M. J.
"The Diffraction of Blast - II," Roy. Soc. London Series A pp. 554-565, Feb. 22, 1950.

Cb50. Uhlenbeck,
"Diffraction of Shock Waves Around Various Obstacles," UM-Q-1. (Univ. of Mich.)

Cb50. Weiss, S. E., and Hamrick, L. A.
"A Catalog of OSRD Reports---Division 2---Effect of Impact and Explosion," Lib. of Congress Nav. Research Sec. Jan. 1950.

Cb50. White, D.R., Weimer, D.K., and Bleakney, W.
"The Diffraction of Shock Waves Around Obstacles and the Resulting Transient Loading of Structures," Tech. Rpt. II-6. Princeton Univ. Dept. of Phys. 1950.

Cb50. Bleakney, W.
"An Experimental Study of the Interaction of Shock Waves," File No. NOLR-QQER. (1950?)

Cb50. "The Effects of Atomic Weapons," U.S. Dept. of Defense and AEC.

See Ca50.

Cb49. Bleakney, Walter
"Tentative Report, Diffraction of a Shock Wave Around an Obstacle - Rectangular Block, Dec. 7, 1949---Triangular Block, Dec. 27, 1949," Princeton Univ. Dept. of Physics NR061-020 N6ori-105, Test II.

Cb49. Bleakney, W., and Taub, A.H.
"Interaction of Shock Waves," Rev. of Mod. Phys. v. 21, n. 4, p. 584, Oct. 1949.

Good on formation of Mach stem, etc.

Cb49. Fletcher, C.H., Weimer, D.K., and Bleakney, W.
"Experimental Measurement of the Density Field in the Mach Reflection of Shock Waves," Phys. Rev. v. 75, n. 8, p. 1294, FA 13, Apr. 15, 1949.

Cb49. Fletcher, C.H., Weimer, D.K., and Bleakney, W.
"The Density Field in Mach Reflection of Shock Waves," Phys. Rev. v. 76 n. 2 p. 323, July 15, 1949.

Cb49. Lighthill, M.J.
"The Diffraction of Blast-I," Roy. Soc. London Proc. Series A 198: 454-70, Sept. 7, 1949.

Behavior of plane shock of any strength, traveling along wall, when it reaches corner of wall turning through small angle.

Cb49. Stoner, R.G., and Glauberman, M.H.
"Refraction of Shock Waves at a Gas Interface," Phys. Rev. v. 76 n. 6, p. 882, Sept. 15, 1949.

Cb48. Cole, R.H.
"Underwater Explosions," Princeton Univ. Press, 437pp. 1948.

Study of scaling laws.

Cb48. Forslind, Erik
"Effect of Dynamic Forces on Structures," Int. Assoc. Bridge Struc. Engr., 3rd Cong. pp.689-697, Sept. 1948.

Contents; The nature of dynamic load as produced by explosives and impact; the properties and behavior of some building materials under the action of dynamic load; characteristic deformation properties of columns, beams and slabs; questions with regard to their mode of function in various structural systems.

Cb47. Feldovich
"On the Reflection of a Plane Detonation Wave," CR Acad. Sci. URSS 55:587, 1947.

Cb47. Finkelstein, R.
"The Normal Reflection of a Shock Wave," Phys. Rev. 71:42, 1947.

Cb46. Friedlander
"The Diffraction of Sound Pulses," Roy.Soc. Proc. A186:322,1946.

Cb46. Herpin
"On the Reflection of Shock Waves," CR Acad.Sci.Paris 223: 276, 1946.

Cb45. Halverson, R.R.
"The Effect of Air Burst on the Blast from Bombs and Small Charges, part II, the Analysis of Experimental Results," OSRD Rpt. No. 4899, 1945.

Cb45. Smith, L.G.
"Photographic Investigation of the Reflection of Plane Shocks in Air," (Final Report) OSRD Rpt. n.6271, 1945.

Cb45. Read, W.T.
"Theory, Calibration and Use of Diaphragm Blast Meters," NDRC A-392, OSRD 6463 Dec. 1945.

Cb44. Keenan, P.C., and Seeger, R.J.
"Analysis of Data on Shock Intersections, Progress Report No. I," Explosives Research Report No. 15 Navy Dept. Bur. of Ord., Washington, D.C., Feb. 3,1944.

Cb44. Polachek, H., and Seeger, R.J.
"Regular Reflection of Shocks in Ideal Gases," Bu.Ord. Explosives Research Rpt. no.13, Navy Dept. Bu.Ord. Washington, D.C., Feb.1944. Also: "Interaction of Shock Waves in Water-like Substances," Bu.Ord ERR No.14, Aug.14,1944.

Cb43. Chandrasekhar, S.
"The Normal Reflection of a Blast Wave," File No. BRL-439 Dec. 1943.

Cb32. Schardin, H.
"Remarks on the Pressure Equalization Process in a Transmission Tube," *Physik Zeitschr no. 2, p. 60, Jan. 15, 1932.* (In German)

Cb1895. Sommerfeld, A. S.
"Mathematical Theory of Diffraction," Math. Amn. 47:317, 1895. (In German)

Cc. BLAST LOADING---SHOCK TUBE STUDIES

Cc51. Duff, R.
"The Use of Real Gases in a Shock Tube," UM-51-3. (Univ. of Mich.)

Cc50. Lobb, R.K.
"The Study of Supersonic Flows in a Shock Tube," Univ. of Toronto, May 1950.

Cc50. Lukasiewicz, J.
"Flow in a Shock Tube of Non-uniform Cross Section," National Research Council, Canada, Report No. MT-11, Jan. 1950.

Cc50. Lukasiewicz, J.
"Shock Tube Theory and Applications," Report No. MT-10, National Research Council, Canada, Jan. 1950.

Cc49. Bleakney, Weimer, and Fletcher
"The Shock Tube: A Facility for Investigations in Fluid Dynamics," Rev. Sci. Inst. 20:807, 1949.

Cc49. Donaldson, C. du P., and Sullivan, R.D.
"The Effect of Wall Friction on the Strength of Shock Waves in Tubes and Hydraulic Jumps in Channels," NACA TN 1942, Sept. 1949.

Cc49. Geiger, F.W.
"The Shock Tube as a Tool for the Investigation of Flow Phenomena," Phys. Rev. v.76, n.6, p.881 D2 Sept. 15, 1949.

Cc49. Mautz, C.W.
"Factors Affecting the Production of Steady Flow Past Models in the Shock Tube," Phys.Rev. v.76, n.1 p.172 item 14, July 1, 1949.

Cc49. Patterson, G.N.
"Theory of the Shock Tube," NOLM 9903 Sept. 21, 1948. Also: Phys. Rev. v.75 p.1294 FA8 Apr. 15, 1949.

Cc49. Rudinger, G.
"Note on the Use of the Shock Tube as an Intermittent Supersonic Wind Tunnel," Phys.Rev. v.75 n.12 p.1948, June 15, 1949.

Cc49. Weimer, D.K., Fletcher, C.H., and Bleakney, W.
"Transonic Flow in a Shock Tube," J. Appl. Phys. v.20 n.4 p.418, Apr. 1949.

Cc48. Emrich, R.J.
"Velocity Loss Measurements on Shocks in a Shock Tube," Princeton Univ.Dept. of Physics NR 061-020 Nov. 18, 1948.

Cc48. Mautz, C.W., Geiger, F.W., and Epstein, H.T.
"On the Investigation of Supersonic Flow Patterns by Means of the Shock Tube," Phys. Rev. v.74 n.12 O 1872 Dec.15, 1948.

Cc46. Payman, W., and Shepherd, W.C.F.
"The Disturbance Produced by Bursting Diaphragms with Compressed Air," Roy.Soc.Proc. Series A, v.186 n.1006 Sept. 1946.

Shock Tube 2.54 cm. in dia.

Cc45. Fletcher, J.C., Read, W.T., Stoner, R.G., and Weimer, D.K.
"Final Report on Shock Tube, Piezoelectric Gauges and Recording Apparatus," NDRC A-356, OSRD 6321 Nov.17, 1945.

Cc43. Reynolds, G.T.
"A Preliminary Study of Plane Shock Waves Formed by Bursting Diaphragms in a Tube," NDRC A-192, OSRD 1519 June 15, 1943.

Cc42. Guderley, G.
"Unsteady Gas Flows in Thin Tubes of Variable Cross-section," ZWB FB 1744, Oct.22, 1942. NRC TT-82, 1948.

Cc41. Payman, W., and Shepherd, W.F.C.
"Explosion Waves and Shock Waves - Pt.VI, the Disturbance Produced by Bursting Diaphragms with Compressed Air," Ministry of Supply, Advisory Council 735, Phys/Ex. 98 (W-12-157) 1941.

Cc28. Payman, W.
"Shock Tubes," Roy.Soc.Proc. A 120:95, 1928.

Cc03. Dixon, H.B.
"Shock Tubes," Phil.Trans. A 200:315, 1903.

Da. ELASTIC STRUCTURAL DYNAMICS---GENERAL THEORY AND METHODS

Da51. Alford, J.L., Housner, G.W., and Martel, R.R.
"Spectrum Analyses of Strong Motion Earthquakes," Earthquake Research Lab., Calif. Inst. of Tech., Pasadena, Calif., Aug. 1951. 110pp.

Spectrum is plot of response of simple oscillator vs period of oscillator. 88 spectra computed by electric analog under ONR contract. Damping found very important in overall problem, relatively small amounts reduce structural response sharply. When damping included, spectra are consistent with hypothesis of distribution about a mean value. Concept of "dominant ground period" is not valid for purpose of aseismic structural design. Proposed that mean value of damped spectrum be used as a quantitative measure of earthquake intensity.

Da51. Allen, D.N. de G., and Severn, R.T.
"The Application of Relaxation Methods to the Solution of Non-Elliptic Partial Differential Equations," J. Mech. and applied Math. v.IV Pt.2, 1951. (Separate)

Illustrated method of converting problems where end conditions are all stated at one end of the range of integration to one where end conditions to be imposed are equal at both ends.

Da51. Dengler, M.A., and Goland, M.
"Transverse Impact of Long Beams, Including Rotatory Inertia and Shear Effects," Tech. Rpt. Engr. Mech. Div. Midwest Research Inst., Kansas City, Mo. 1951.

To clarify the stress propagation phenomena in impacted beams, closed solutions are deduced for the stresses induced in a long beam of uniform section by the action of an impulsive, concentrated transverse load. Rotatory inertia and shear are accounted for in the differential equation. For the special case when the Young's modulus and the effective transverse shearing modulus of the beam are equal, the results take on a simpler form and numerical evaluation of the stresses is readily accomplished. When this equality of properties does not hold, numerical evaluation of the solutions is difficult and methods will have to be developed to permit this.

Da51. Marcus, Henri
"Introduction to Theory of Dynamic Behavior of Structures," Div. of Civ. Engr., Univ. of Calif., Berkeley, 1951. 200pp. mimeographed.

Da51. Siddall, J.W., Isakson, G., and Bisplinghoff, R.L.
"Approximate Analytical Methods for Determining Natural Modes and Frequencies of Vibration," MIT ASR Rpt. no. 7833-51-1 184pp Jan. 16, 1951.

51. [illegible] and Goodman, L.E.
[illegible] Prismatic Bars Including Rotatory Inertia [illegible]ctions," Tech. Rpt. to the Office of Naval [illegible] E. Dept. Univ. of Ill.; 23pp. April 15, 1951.

[illegible] Charles S., Anderson, B.G., and Salvadori, M.G.
[illegible]omprehensive Numerical Method for the Analysis of Earthquake Resistant Structures," J. Am. Conc. Inst., Sept. 1951, pp. 5-28.

Step-by-step method for analysis of earthquake stresses in rigid frame buildings developed from authors' experience with blast problems in structures. Method can be extended to case of plastic strains. Examples of five story building subjected to various base displacements. Damping and ground rocking considered. Rigorous solution feasible for five or less stories; step-by-step thereafter. Step-by-step method preferable when plastic hinges considered. Desk calculator or IBM techniques suitable. Errors of calculation less than with previously developed procedures by Timoshenko, Newmark.

Da51. Zizicas, George A.
"Dynamic Buckling of Thin Simply Supported Plates in the Elastic Region," Univ. of Calif., Los Angeles Research Report, 96pp. May 1951.

Dynamic effects negligible for loading times greater than a few multiples of fundamental period of plate, but they are an essential feature of the phenomenon for times of loading of the order of the fundamental period or smaller. For sufficiently small intervals of loading, the critical buckling load may be exceeded without danger, while for loads under the critical, the displacement may be up to twice as high as the static analysis would predict.

Da50(?) Duwez, P.E., Clark, D.S., and Bohnenblust, H.F.
"The Behavior of Long Beams Under Impact Loading," J. Applied Mech. paper no. 49-SA-1 (Unpublished as of March 3, 1950.)

Da50. Isakson, G., and Bisplinghoff, R.L.
"Report on a Survey of Analytical Methods for Determining Transient Stresses in Elastic Structures," MIT Aero-Elastic and Structures Research Rpt. No. 7833-50-3-3, 64pp. 1950.

Da50. Felgar, Robert P., Jr.
"Formulas for Integrals Containing Characteristic Functions of a Vibrating Beam," Circular No. 14 Bur. of Engr. Research Univ. of Texas. 55pp. 1950.

Da50. Newmark, N.M.
"Methods of Analysis for Structures Subjected to Dynamic Loading," Univ. of Ill. report to Air Force Vulnerability Branch of Air Targets Div., D r. of Intelligence, Washington, D.C. Dec. 18, 1950.

Contents: The procedures of analysis are applicable to loadings caused by wind, earthquake, or impact, as well as blast. The principal type of approximate method considered is a method based on the assumption of a shape or mode of deformation, in effect reducing the number of degrees of freedom of the structure to one. A general method and several approximate methods are given which are especially applicable to structures which are stressed to the point of failure and therefore which are loaded considerably beyond their range of elastic behavior. Fairly good results are given for the limiting conditions at or near failure of the structure.

Da50. "A Selected Bibliography on Vibrations in Structures," Dept. of Science and Industrial Research, Bldg. Res. Sta. (England) Library Bibliography No. 152, 12pp.

General theory, mathematical treatment, etc. Machinery vibration. Blasting and pile driving. Road and rail vehicles. Structures, ground, and foundation design. Human sensitivity. Instruments. Seismology and geophysics. Misc. 135 items.

Da50. Penzien, Joseph, and Williams, Harry A.
"A Discussion of the Dynamic Analysis of a Frame Subjected to an Impulsive Load," MIT report to New England Division Corps of Engineers, Contr. DA-19-016-eng-239, Aug. 1950.

Gives detailed results of studies concerning analysis or design of framed building loaded by atomic bomb blast. Various methods explored, errors due to simplified approaches found. For best results in analyzing a final design, the general step-by-step procedure, assuming linear variation of acceleration is recommended. The simplified step-by-step method which assumes infinitely rigid girders is recommended for preliminary design. The average rate of stress build-up for the structure and loading conditions assumed for this investigation was rapid enough to warrant an increase in the yield point of steel.

Da50. Pian, T.H.H., and Hallowell, F.C., Jr.
"Investigation of Structural Damping in Simple Built-up Beams," MIT ASR Rpt. No. 7833-50-2-2, 1950.

Da50. Pian, T.H.H., Siddall, J.N., and Bisplinghoff, R.L.
"Dynamic Buckling of Slender Struts," MIT ASR Rpt. No. 7833-50-5 May 2, 1950. 68pp.

Da50. Pian, T.H.H., Mar, J.W., and Bisplinghoff, R.L.
"An Experimental Study of the Behavior of Beams under Dynamically Applied Bending Moments," MIT ASR Rpt. No. 7833-50-10, 28pp. Oct. 24, 1950.

Da49. Evaldson, R.L., Ayre, R.S., and Jacobsen, L.S.
"Response of an Elastically Non-Linear System to Transient Disturbances," Franklin Inst. J. v.248 n.6 pp. 473-494, Dec. 1949.

"The problem relates to an undamped, elastically non-linear, single-degree-of-freedom lumped system subjected to three forms of ground motion pulses (rectangular, cosine, and "skewed" cosine); each form consists of a single pulse, the duration of which has been varied over a wide range."

Da49. Fotieo, G., and Zartarian, G.
"Flutter Analysis of a Wing with Concentrated Masses by Means of Station Functions (Phase 4)," MIT ASR Rpt. No. 8790-49-4-15, 1949.

Da49. Frankland, J.M.
"Effects of Impact on Simple Elastic Structures," Soc. Exp. Stress Anal. Proc. v. VI n.2, 1949.

Definitions of terms used in study of impact loading---discussion of different cases---with comparison of theoretical and actual cases.

Da49. Hudson, G.E.
"A Method of Estimating Equivalent Static Loads in Simple Elastic Structures," Soc. Exp. Stress Anal. Proc. v.VI, n.2, 1949.

Da49. Isakson, G., Bisplinghoff, Pian, Flomenhoff, and O'Brien
"An Investigation of Stresses in Aircraft Structures Under Dynamic Loading," MIT ASR Rpt. No. 8790-49-8-24, 1949.

Da49. Jacobsen, L.S.
"Transverse Vibration of One and of Two Span Beams under the Action of a Moving Mass Load," Stanford Univ. Tech. Rpt. No. 7, Oct. 1949.

Da49. Pian, T.H., and O'Brien, T.F.
"Further Developments in Methods of Transient Stress Analysis During Landing," MIT ASR Rpt. No. 8790-49-7-1, 1949.

Da49. Pian, T.H.H., Siddall, J.N., and Bisplinghoff, R.L.
"The Prediction of Stresses in a Structure under an Arbitrary Dynamic Loading," MIT ASR Rpt. No. 7833-49-7-15 31pp. July 1949.

Da49. St. Rydlewski
"Natural Vibrations in a Truss with Rigid Joints," (in French). Arch. Mech. Stos.2, 99-119, 1949.

Frequency equations obtained for rigid joint trusses. Good for short spans where Polhausen's method fails.

Da49. White, M.P.
"On the Impact Behavior of a Material with a Yield Point," J. App. Mech. v. 16 n.1. p. 39, March 1949.

Young, Dana, and Felgar, R.P., Jr.
"Tables of Characteristic Functions Representing Normal Modes of Vibration of a Beam," Univ. of Texas Pub.No.4913, July 1, 1949, 31pp.

Clamped-clamped, free-free, clamped-free, clamped-supported, and free-supported beams.

Da48. Odman, Sven T.A.
"Differential Equation for Calculation of Vibrations Produced in Load-bearing Structures by Moving Loads," Int. Assoc.Br. and Structural Engr., 3rd Cong. pp. 669-680, Sept. 1948.

Method applies characteristic functions, so that differential equation holds good for any arbitrary boundary conditions and for several non-elastic moving loads; approximate solution.

Da48. Rauscher, M., Zartarian, G., and Haley, S.M., Jr.
"Comparison of Theoretical Methods of Calculating Vibration Modes and Flutter Speeds (Phase 1)," MIT ASR Rpt. No. 879-48-11-15, 1948.

Da47. Claflin, W.M.
"The Experimental Determination of the Dynamic Structural Response of an Airplane to Impact Loadings," Soc. for Exp. Stress Anal. Proc. v.V n.1 pp. 31-38, 1947.

Design and testing of a model, dynamically similar to an actual airplane. Nondimensional "amplification factors" are determined. Gives brief review of the basic theory of dynamic response.

Da47. Pfeiffer, G.
"On the Differential Equation for the Transverse Vibrations of a Beam," (In German) *Zangew Math.Mech. v. 25/27 n. 3, June 1947.*

Da46. Robertson, J.M., and Yorgiadis, A.G.
"Internal Friction in Engineering Materials," J. App. Mech. v.13 n,3, Sept. 1946.

Da46. Spotts, M. F.
"Impact Stress in Elastic Bodies Calculated by the Energy Method," Product Eng. 17:200-4, Mar. 1946.

For bars and beams; calculation of stresses due to moving weights.

Da46. Wilbur, J. B.
"Action of Impulsive Loads on Elastic Structures," Boston Soc. Civ. Engrs. J. v.33 n.3 pp.163-73, July 1946.

Discussion of methods of analyzing structure for bending moments, shear and direct stresses caused by impulsive loads (blast loads, impact loads and ground shock due to bombing); investigations refer to elastic bodies with one or more degrees of freedom, i.e., bodies whose position can be defined by means of one or more dimensions; plastic instead of elastic analysis indicated.

Da45. Stowell, E. Z., Schwartz, E. B., and Houbolt, J. C.
"Bending and Shear Stresses Developed by the Instantaneous Arrest of the Root of a Moving Cantilever Beam," Rpt. No. 828 Natl. Adv. Comm. for Aeronautics 1945.

Theoretical and experimental investigation of behavior of a cantilever beam in transverse motion when its root is suddenly brought to rest. Equations for acceleration, deflections, stresses: test on small tube cantilever.

Da44. Biot, M. A., and Bisplinghoff, R. L.
"Dynamic Loads on Airplane Structures during Landing," App. III NACA ARR 4H10 Oct. 1944.

Da43. Biot, M. A.
"Analytical and Experimental Methods in Engineering Seismology," Trans. ASCE 108:365-408, 1943.

Status of the science [redacted]. Many excellent discussions. References.

Da43. Wilbur, John B.
"The Analysis of Elastic Structures Acted upon by Impulsive Loadings," NDRC Rpt. No. A-219 (OSRD No. 1915) 1943.

Develops concept of dynamic load factor by means of which one analyzes the dynamic behavior of beams and slabs, through the use of characteristic shapes and loads. It is shown that a dynamic load factor curve can be developed for each type of impulsive loading. A factor can then be applied readily to the impulsive load value to produce an equivalent static loading. Slabs are analyzed approximately by reducing them to an equivalent beam grid.

Da42. Pipes, L. A.
"The Operational Theory of Longitudinal Impact," J. App. Phys. Aug. 1942.

Da42. Prescott, John
"Elastic Waves and Vibrations of Thin Rods," Phil. Mag. v.33, 7th Series 1942.

Da42. Robertson, H.P., and Slutz, R.J.
"The Reactions of Thin Beams and Slabs to Impact Loads, Part I, Theory; Part II, Beams," Natl. Research Council Comm. on Passive Protection against Bombing, Interim Rpt. Nos. 13 and 14. 1942.

Da41. White, Merit P.
"Friction in Buildings," Bull. Seis. Soc. Am. v.31, Apr. 1941.

Da40. Lee, E.H.
"Impact of Mass Striking a Beam," Am. Soc. Mech. Engrs. Trans. (J. App. Mech.), v.7 n.4 p.A-129-38, Dec. 1940.

Paper deals solely with central impact on beam simply supported at ends; no difficulties encountered in generalizing method for impact at any point along beam; development leads to similar conclusions, relations being expressed in terms of normalized characteristic functions for modes of vibration. Biblio.

Da39. Jacobsen, L.S.
"Natural Periods of Uniform Cantilever Beams," Trans. ASCE 1939, p. 402.

Da34. Creskoff, Jacob J.
"Dynamics of Earthquake Resistant Structures," McGraw-Hill, 128pp. 1934.

Dynamics of earthquake motion: deflections of beams in moment and shear; free transverse vibrations of a slender beam; forced transverse vibrations of a slender beam; distribution of seismic shear and moment; application to buildings; aseismic design of a tall building; aseismic design of a short building.

Da33. Biot, M.
"Theory of Elastic Systems Vibrating under Transient Impulse, with an Application to Earthquake-proof Buildings," Nat. Acad. Sci. Proc. v.19 n.2, 1933.

General method of evaluating random impulses on vibrating systems.

Da30. Donnell, L.H.
"Longitudinal Wave Transmission and Impact," Trans. ASME App. Mech. Div. 52 pt1: 153, 1930.

Da?? Uflyand, Y.S.
"Propagation of Waves in Transverse Vibrations of Beams and Plates," (In Russian) *Prikladnaya Matematika i Mechanika (USSR) vol. XII no. 3.*

Db. ELASTIC STRUCTURAL DYNAMICS---MODELING

Db50. Hermes, R.M., and Yen, C.S.
"Dynamic Modeling for Stress Similitude." Univ. Santa Clara, Calif. Tech.Rpt. No.2 to ONR Contract No. N8 onr-423, June 1950.

Modeling methods for dynamic stress analysis and the concept of engineering accuracy are briefly discussed. Summary of the results of the analytical work on dynamic modeling of beams presented previously are given. The conclusions of the previous analysis is verified, namely: for those applications where damping can be neglected, modeling for stress similitude can be attained if the dimensionless radius of gyration is the same for prototype and model; and those applications where internal damping is of importance, geometric similarity between prototype and model is necessary.

Db49. Hermes, R.M., and Yen, C.S.
"Dynamic Modeling for Stress Similitude," Univ. Santa Clara Tech.Rpt. No.1 to ONR Contract N8 onr-t23 July 1949.

Method of rendering the equations of motion of a vibrating beam in dimensionless form is presented. Parameters, which must be kept constant for model similitude, are derived. Internal damping is considered and the conclusion is reached that it can be satisfactorily modeled. Effect of internal damping is recognized and evaluated. The eigen-functions in dimensionless form are summarized for each of the six types of vibrating beams; also frequency equations. These functions are shown to be normalized with proper choice of coefficients.

Db39. White, M.P. and Byrne, R.E.
"Model Studies oi the Vibrations of Structures during Earthquakes," Bull.Seis.Soc.Am. 29:327-332, 1939.

Db38. Ruge, Arthur C.
"Earthquake Resistance of Elevated Water Tanks," Trans. ASCE 103:889-949, 1938.

Results of model tests. Experimental methods. Similarity. New type of spring-element diagonal investigated.

Db38. "Structural Models," C and R Bull. #13, USN Dept., Bur. Construction and Repair, Washington, D.C., U.S. Govt. Print.Off.

Part I --- Theory 1938
Part II --- Model Investigations of Armored Structure 1940

Db35. Beggs, R.D., and Davis, H.E., and Davis, R.E.
"Tests on Structural Models of Proposed San Francisco-Oakland Suspension Bridge," Univ. of Calif. Pub. in Engr. v.3 n.2, 1935.

Includes dynamic model theory and a complete (as of 1935) bibliography on model testing and dimensional analysis.

Db34. Bull. Seis. Soc. Am. July 1934, pp. 170-230.

Dc. ELASTIC STRUCTURAL DYNAMICS---PROPAGATION OF STRESS AND STRAIN

See also: Da42 Prescott

Dc51. Malvern, L.E.
"The Propagation of Longitudinal Waves of Plastic Deformation in a Bar of Material Exhibiting a Strain-Rate Effect," J. App. Mech. v.18 n.2 pp.203-209 June 1951.

The theory of propagation of longitudinal waves of plastic deformation is extended to apply to materials in which the stress is a function of the instantaneous plastic strain and strain rate. Solutions are given for an idealized flow law and compared with solutions based upon earlier theories which neglect strain-rate effect.

Dc51. Lee, E.H., and Wolf, H.
"Plastic-wave Propagation Effects in High Speed Testing," Quarterly App.Math. p.405, Jan.1951.

Dc51. Rinehart, John S.
"Some Quantitative Data Bearing on the Scabbing of Metals under Explosive Attack," J. App. Phys. v.22 n.5, May 1951.

Dc50. Thornton, D.L.
"Applications of Stress Propagation in Civil Engineering," Engr. 169:689-92, June 16,1950.

By means of strain gages and a cathode-ray oscillograph, records of the variation of strain with time is shown of a steel bar. Discussion of propagation of pressure-pulse of short duration when the amplitude of the strain-wave has exceeded the proportional limit of both ductile and brittle materials, including mathematical treatment and some experimental results for structural concrete elements.

Dc50. von Karman, T., and Duwez, P.
"The Propagation of Plastic Deformation in Solids," J.App.Phys. v.21 n.10 pp.987-994 Oct. 1950.

Theoretical and experimental study of longitudinal impact at end of bar; experiments on propagation of plastic strains in specimen subjected to tension impact.

Dc49. Clark, D.S., and Wood, D.S.
"The Time Delay for the Initiation of Plastic Deformation at Rapidly Applied Constant Stress," Am.Soc.Test.Mat. Proc.49:717-737, 1949.

"The design and construction of a special rapid-load testing machine is described with which tensile loads may be applied to a specimen within 5 milli-seconds and longer. Tests made on annealed low-carbon steel are presented and discussed in detail. ---It is concluded that the time delay is associated with the yield point of mild steel."

Dc49. Vigness, I.
"Propagation of Transverse Waves in Beams," NRL Rpt. F-3476 Naval Research Lab., Washington, D.C. June 1949.

Dc47. Cooper, J.L.B.
"The Propagation of Elastic Waves in a Rod," Phil. Mag. v.38, 7th Series 1947.

Dc47. Duwez and Clark
"An Experimental Study of the Propagation of Plastic Deformation under Conditions of Longitudinal Impact," Am. Soc. Test. Mat. Proc. 47:502-523, 1947.

The theory of plastic strain propagation is reviewed with reference to longitudinal impact. Special impact testing equipment is described. Tests in tension on long wires and on specimens of other gage lengths are reported, together with the results of some tests made in compression. The effect of release of loading and reflection of plastic strain waves on plastic strain distribution are considered. The concept of critical velocity is discussed. The anomalous behavior of material for which there is a yield point is presented. Results indicate very satisfactory agreement between theory and experiment.

Dc47. Sar[illegible], Zener, Dorn. and Others
"Fracturing of Metals," Published by the American Soc. of Metals, 311pp. (Cleveland, Ohio) 1947.

A seminar on the fracturing of metals. Following gives titles of typical subjects treated: "The Micro-Mechanism of Fracture," "The Effect of Stress State on the Fracture Strength of Metals," "Effect of Strain on Fracture," --- includes 14 other articles.

Dc46. Taylor, G.I.
"Testing of Materials at High Rates of Loading," Instn. Civ. Engrs. J. v.26 n.8 Oct. 1946 (PP486-519).

Methods of determining properties of materials subject to impact loading such as Hopkinson's experiment, bouncing-ball experiments, tests in which yield point is passed; influence of rate of strain, impact at very high speeds, study of stress waves in plastic materials; illustrated description of Mann's high-velocity tension impact machine. Bibliography.

Dc45. Duwez, P.E., Martens, H.E., and Clark, D.S.
"Preliminary study of the influence of rapid loading and time at load on the initiation of plastic deformation in tension," Report No. M-450 National Defense Research Committee (Office of Scientific Research and Development No. 4621) Jan. 22, 1945.

Dc44. Bohnenblust, Henri Frederic
"A Note on Von Karman's Theory of the Propagation of Plastic Deformation in Solids," A-41M OSRD 664 June 25, 1944.

Dc42. Bogosian, A., and O'Brien, E.H.
"Report on the Construction of a Wind Tunnel Model Wing (SBU2) Whose Dynamic and Elastic Characteristics are Proportional to the Full Scale Wing," MIT ASR Rpt. No. 74858-42-4-2, 1942.

Dc42. Flügge, W.
"The Propagation of Bending Waves in Beams," (In German) *Z. Angew. Math. Mech. v. 22 n. 6 Dec. 1942.*

Dc42. Zener, C., and Hollomon, J.H.
"Addendum to Von Karman's Theory of the Propagation of Plastic Deformation in Solids," A-37M OSRD 659 June 1942.

Dc35. Glanville, Grime, and Davis
"Behavior of Reinforced Concrete Piles During Driving," J. Instn. Civ. Engrs. v.1, 150-234, 1935.

Extremely extensive (80 pp.) theoretical and experimental study, math. theories given; study of stress propagation.

Dc32. Fox, E.N.
"Stress Phenomena Occurring in Pile Driving," Engr. 134: 263, 1932.

Application of elastic wave theory to pile-driving phenomena. Rather thorough math treatment. British.

Dc27. Griffith, A.A.
"The Phenomena of Rupture and Flow in Solids," Trans. Royal Soc. 10:402, 1927.

Dc?? Karman, Th. v, Bohnenblust, H.F. and Hyers, D.H.
"The Propagation of Plastic Waves in Tension Specimens of Finite Length," NDRC Report A-103 (OSRD No. 946).

Ea. THEORIES OF FAILURE---BRITTLE FAILURE

Ea50. Bateson, H.M.
"Some Views on the Breaking of Glass Derived from the Examination of Fracture Surfaces," Soc. Glass Tech. J. v. XXXIV n. 158 pp. 114-118, June 1950.

Ea49. Haward, R.N.
"The Strength of Plastics and Glass," (A Study in Time-Sensitive Materials). Interscience Publishers, 245pp. 1949.

Ea49. Jones, G.O.
"The Interpretation of the Experimental Data on the Strength of Glass," Soc. Glass Tech. J. v. XXXIII n. 151 pp. 120-137 April 1949.

"The main conclusions of experimental work on the strength of glass are discussed from the point of view of the Griffith flaw theory and of later theories of the strength of solids. An attempt is made to present a broadly correct interpretation of the phenomena and to suggest why other explanations of particular phenomena may be incorrect."

Ea48. Frankel, Jacob Porter
"Relative Strengths of Portland Cement Mortar in Bending Under Various Loading Conditions," Am. Conc. Inst. J. 20: 21-32, 1948.

Assuming the behavior of standard mortar to be similar to that of plain concrete, tests were performed on 99 small mortar beams under sixth, third and center-point loading to verify the applicability of the statistical theory of the strength of brittle materials to concrete construction.

Ea48. Lethersish, W.
"A Theory of the Transition from Tough to Brittle Fracture with Special Reference to Velocity Effects in Impact Testing," 7th Int. Cong. App. Mech. Proc. 1, pp. 61-73, 1948.

The energy to fracture, and tensile strength are discussed in terms of a very simple model, with fracture obeying maximum strain laws for both brittle and tough behavior. For brittle fracture, it is assumed that the hydrostatic component of the state of stress controls, while the shear component controls ductile behavior.

Ea47. Fisher, J.C., and Hollomon, J.H.
"Statistical Theory of Fracture," Am. Inst. Min. and Met. Engrs. Tech. Pub. No. 2218 for meeting Nov. 1946, 16pp. (Metals Technology v. 14, Aug. 1947).

Review of literature and theoretical mathematical analysis of fracture stress of metallic and non-metallic materials; source of low fracture stress in glass; statistical analysis; ref to work of G. Sachs and J. D. Lubahn on notched bar tests of cohesive strength of steels.

Ea46. Poncelet, E. F.
"Fracture and Comminution of Brittle Solids," Am. Inst. Min. and Met. Engrs. Trans. v. 169, 1946.

Contents: It has been theorized that comminution of brittle solids occurs in the following steps:
(1) Deformation of the solid to be comminuted by the application of outside forces resulting in tensile stresses.
(2) Development of one or more cracks as a direct result of these stresses.
(3) Formation of compression and transverse pulses caused by these breaks to travel through the solid, the later pulses causing the cracks to progress mainly at the critical crack velocity, a constant for the material.
(4) Generation of tension and more transverse pulses by reflection of the compression pulses at the solid's free boundaries, causing offspring cracks to form and progress preferentially in the smaller fragments liberated by the parent cracks.
(5) Formation of residual particles of smaller and smaller sizes as the process is repeated until the whole solid is reduced to a collection of residual particles.

Ea41. Tucker, J., Jr.
"Statistical Theory of the Effect of Dimensions and Method of Loading on the Modulus of Rupture of Beams," Am. Soc. Test. Mat. Proc. v. 41 p. 1072, 1941.

There is an inherent difference in the strength of duplicate test specimens no matter how carefully these specimens are made or tested. Such differences are a natural characteristic of the materials and are more pronounced in some than in others. The paper shows how the variations in the strength of small elements of volume within a specimen will affect the modulus of rupture of beams of different dimensions and beams subjected to different loading. For example, the modulus of rupture of a beam will be decreased with beam depth and with beam length, and will be greater in centrally loaded beams than in similar beams loaded at third points.

Ea39. Weibull, W.
"A Statistical Theory of the Strength of Materials,"
Ingeniorsvetenskapsacademien, Handlingar no. 151, 153, 1939.

Develops a general statistical theory to explain the ultimate rupture strength of materials. Shows that the probability of rupture (S) is such that $\log(1-s) = -\int_v f(\sigma)\, dv$. Empirically determines the function of stress $f(\sigma)$ on the basis of tests of plaster of paris, porcelain, portland cement mortar, wood, cotton yarn, and aluminum castings.

Ea21. Griffith, A. A.
"The Phenomena of Rupture and Flow in Solids," Phil. Trans. A 221:163-198, March 1921.

Establishes a fundamental theory of rupture predicated on the influence of flaws. The flaws permit development of stress concentrations which effectively reduce average stress to cause rupture. Many subsequent works of various authors are based on the "Griffith Flow Theory."

Eb. THEORIES OF FAILURE---PLASTICITY

Eb51. Phillips, Aris
"A General Method of Calculating the Moment-Strain (Max) Diagram in Plastic Bending of Beams," Paper no. 51-APM-6, J. App. Mech. 1951.

A new method is given for finding Moment-Strain (max) curve in the case of a symmetrical pure bending of bars in plasticity.

Eb50. Morrison, J.L.M., and Shepher, W.M.
"Experimental Investigation of Plastic Stress-Strain Relations," Inst. Mech. Engr. Proc. 162 (W.E.P. no. 55): 1-9 pl 1/2; discussion 10-17, 1950.

Eb49. Chamband, M.
"Elastoplastic Theory of Bending in Beams of Reinforced Concrete," *Inst. Tech. Batim Trav. Publ. 101, Nov. 1949.* (In French, 17pp.)

Eb49. Marin, J.
"Stress Strain Relations in the Plastic Range for Biaxial Stresses," J. Franklin Inst. pp. 231-250, Sept. 1949.

Gives results of experimental investigation on thin-walled aluminum alloy tubes subjected to combined tension and torsion. Stress-strain diagrams for plastic range given. Curves, equations, and bibliography given.

Eb49. Prager, W.
"Recent Developments in the Mathematical Theory of Plasticity," J. App. Phys. March, 1949.

Eb49. Swida, W.
"The Elastoplastic Bending of a Curved Bar of Work-hardening Material," *Ingen-Arch 17 n. 4 pp. 343-352, 1948.* (In German)

Relation between bending moment and fiber stress in a curved beam with an assumption that cross section is of such shape that under increasing moment, inelastic action commences at concave surface of beam. Remarks on economy to be realized in working in inelastic range, and solution of problem is indicated for curved stress-strain diagrams.

Eb49. Westwater, J.W.
"Flexure Testing of Plastic Materials," Am. Soc. Test. Mat. reprint (No. 87) 26pp. 1949. (Am. Soc. Test. Mat. 49: 1092, 1949).

Comprehensive theoretical treatment with tests: load-deflection curves; bibliography.

Eb48. Lusion, W.W., and Johnston, Bruce G.
"Plastic Behavior of Wide Flange Beams," Welding J. Research Supplement v.27, 17pp. Nov.1948.

This report presents results of wide flange sections tested as simple beams with third point loading through the elastic and into the plastic range; bending behavior of beam depicted by M (moment) - Ø (rate of change of slope of the beam axis) curves; diagram of elastic stress distributions; local buckling; residual stresses; diagrams of general test setup using SR-4 strain gages; strain distribution diagrams across tension and compression flanges; summary of test results; initial stress condition, initial yield moment, plastic moment, calculated and observed values.

Eb48. Prager, W.
"Problem Types in the Theory of Perfectly Plastic Materials," J. Aero Sc. (15-6) pp.337 June 1948.

Consideration of different problem types; examples discussed; 8pp; bibliography.

Eb48. Prager, W.
"Theory of Plastic Flow vs Theory of Plastic Deformation," J. App. Phys. (19-6) pp.540-543, June 1948.

Typical theories of plastic flow and plastic deformation are discussed, and concept of neutral change of stress is introduced.

Eb48. Prager, W.
"The Stress Strain Laws of the Mathematical Theory of Plasticity---A Survey of Recent Progress," J. App.Phys. (15-3 Quarterly) pp.226-233, Sept.1948.

Eb48. Reiner, M.
"Elasticity Beyond the Elastic Limit," Am.J.Math. v.70 n.2 pp.433-446, April 1948.

Extensive mathematical treatment, 13pp. Bibliography.

Eb47. White, M.P., and Griffis, L.
"The Propagation of Plasticity in Uniaxial Compression," Trans. ASME App.Mech.Div. 69:A-337, 1947.

Eb45. Millowitz, Julius
"The Initiation and Propagation of the Plastic Zone in a Mild Steel Tension Bar," A-309 OSRD 4612. Jan.24,1945.

Eb44. "The Propagation of the Plastic Zone Along a Tension Bar Having a Well-defined Plastic Limit," A-280 OSRD 3864, July 1, 1944.

Eb43. Bridgman, Percy Williams
"Plastic Deformation of Steel Under High Pressure," Progress Reports 1-3 A-95 OSRD 919 Sept. 1942, Sept. 1943.

Eb43. Jensen, V.P.
"The Plasticity Ratio of Concrete and its Effect on the Ultimate Strength of Beams," Am. Conc. Inst. J. p. 565 June 1943.

The hypothesis is advanced that the stress-strain diagram for concrete under short time loading may be idealized for certain purposes so as to consist of two linear parts, one representing elastic behavior and the other representing plastic behavior. The former is measured by the "modular ratio" which is defined as the ratio of the E of steel to the initial E of concrete. The latter is measured by the "plasticity ratio" which is defined as the ratio of the plastic strain to the total strain at rupture of the conc. An empirical equation is given to express the relationship between the plasticity ratio and the compressive strength of the conc. Formulas are derived for the ult str of beams reinf in tension only.

Eb42. Whitney, Charles S.
"Plastic Theory of Reinforced Concrete Design," Am. Soc. Civ. Engrs. Trans. 107:251-326, 1942.

Ec. THEORIES OF FAILURE---LIMIT THEORY

Ec51. Neal, B.G., and Symonds, P.S.
"A Method for Calculating the Failure Load for a Framed Structure Subjected to Fluctuating Loads," Inst.Civ. Engr.J. v.3 pp.186-197, Jan.1951.

Two-span rigid frame. Sequence of loading which may cause failure by incremental collapse is determined.

Ec50. Drucker, D.C.
"Plasticity of Metals; Mathematical Theory and Structural Applications," Am. Soc.Civ.Engr.Proc.76:1-14, Aug.1950.

Gives simple structural applications of plastic design. Example of beam, column, simple A-frame, and three-wire problem.

Ec50. Heyman, J.
"The Limit Design of Space Frames," Tech.Rpt.A18-2 Contract N7 ONR 35806 Brown Univ. 1950.

Ec50. Penzien, Joseph, and Williams, Harry A.
"A Discussion of the Dynamic Analysis of a Frame Subjected to an Impulsive Load," MIT rpt. submitted to New England Div. Corps of Engrs.Contract No. DA-19-016-eng-239 Aug.1950.

This report gives the detailed results of analytical studies of a number of problems which would arise in connection with the analysis or design of a frame building to resist the effects due to a long duration blast. Purpose of study was to explore the various methods of analysis and to establish the errors involved in simplified approaches. For best results in analyzing a final design, the general step-by-step procedure, assuming linear variation of acceleration is recommended. The simplified step-by-step method which assumes infinitely rigid girders is recommended for preliminary design. The average rate of stress build-up for the structure and loading conditions assumed for this investigation was rapid enough to warrant an increase in the yield point of steel.

Ec50. Phillips, Aris
"Symmetrical Pure Bending of Beams in Plasticity," Tech.Rpt.#7 ONR Contract Div.of Engr.Mech. Stanford.

Ec50. Symonds, P.S., and Prager, W.
"Elastic-Plastic Analysis of Structures Subjected to Loads Varying Arbitrarily between Prescribed Limits," J.App.Mech.17:315-323, 1950.

Ec49. Baker, J.F.
"A Review of Recent Investigations into the Behavior of Steel Frames in the Plastic Range," J. Instn. Civ. Engrs. 31:188-240 Jan. 1949.

Ec49. Baker, J.F.
"The Design of Steel Frames," J. Instn. Structural Engrs. 27:397, 1949.

Presents an engineering approach to the design of portal frames, multi-storied building frames, and gabled bents by means of the principle of "Limit Design." An extensive bibliography, in which the author's earlier works are completely referenced, is provided.

Ec49. Powell, E.G.S.
"Don't be an Ostrich---'Limit Design' is Safer and More Economical," New Zealand Eng. v.4 nos.1/2, Jan.-Feb. 1949.

Factor of safety of 2 against plastic yield is considered desirable; numerical examples show that actual factor of safety or overload margin is much greater against failure than against plastic yield point assumed in calculations.

Ec48. Baker, J.F., Thomas, W.N., Williams and Lax.
"The Civil Engineer in War," A symposium of papers on war-time engineering problems, v.3. Published by Instn. Civ. Engrs., Great George St., London, S.W.1., 1948.

Contents: "Plasticity as a Factor in the Design of War-time Structures," (Baker), Elementary theory of plastic bending, basement strengthening, surface shelters, indoor shelters, protection of factories. "The Effects of Impulsive Forces on Materials and Structural Members," Prof. Thomas. "The Design of Frame Buildings against High Explosive Bombs," Prof. Baker, Williams and Lax.

Ec48. Kirkwood, J.G., and Richardson, J.M.
"The Plastic Deformation of Circular Diaphragms under Dynamic Loading by an Underwater Explosion Wave," OSRD Rpt. No. 4200, 1944.

A study of plastic deformation of circular plates under various constraints.
(This work is summarized, and references to other authors are given in "Underwater Explosions," by R. H. Cole, Princeton Univ. Press, Chapter 10.)

Ec48. Van den Broek, J.A.
"Theory of Limit Design," Wiley, 1948.

Ec47. Horne, M.R.
"A Moment Distribution Method for Rigid Frame Steel Structures Loaded beyond the Yield Point," British Welding Research Assoc. (Special Report no.25.)
(Also: Welding Research v.1 n.3 Aug.1947)
(Also: Inst.Weld.Trans.v.10, Weld Research Sec. pp.6-15, Aug. 1947).

Ec47. Hrennikoff, A.
"Theory of Inelastic Bending with Reference to Limit Design," Am..Soc.Civ.Engr.Proc.73:255-89, Mar.1947; discussion 73: 944-6, 1293-301; 74:277-82, 377-80 June-Oct.1947, Feb.-Mar.1948.

This paper contains the description of a method for analyzing statically indeterminate flexural structures loaded beyond the elastic limit or structures of materials that do not obey Hooke's law. Contents are as follows: Stress-strain relations in I-beam, channel beams: deflections; shearing stresses in beams: elastic range, plastic range: effect of shear stresses; stress recession: computation of shape constants of an I beam: deflections, strains, stresses, and moments under capacity loading; deformation data: limit design: yielding points, critical sections.

Ec47. Panlilio, F.
"Theory of Limit Design Applied to Magnesium Alloy and Aluminum Alloy Structures," Roy. Aero. Soc. J.51:534-71, June 1947.

Extensive series of tests on beams. Gives background of limit design theory. Gives many defl-load curves. Good bibliography.

Ec45. Richardson, John M.
"Theory of the Plastic Deformation of Thin Plates with Applications," A-344 OSRD 5660, Oct.19,1945.

Ec44. Beskin, L.
"Predicting Ultimate Failure Loads," Mach.Design v.16 n.12 pp.117-24,Dec.1944.

Margin of safety against failure by fracture depends upon plastic behavior of materials rather than elastic action commonly assumed in calculating working stresses; using simplifying assumption, author develops equations and charts for predicting ultimate failure loads of parts subjected to bending and to eccentric loading. (Discussion confined essentially to failure of small metal machine parts.)

Ec44. White, Merit P.
"The Limit Design of Structures Subjected to Impulsive Loads - with Application to Military Structures," (OSRD Report No. 4192) NDRC Report No. A-293, 40pp. Sept. 1944.

Design of military structures should be based on a dynamic analysis, and analysis should be in terms of ultimate loads. For impulsive loading, the important quantity normally is not the maximum force applied but rather the amount of energy the structure can absorb before collapse. In a typical structure (a simple reinforced conc beam) the energy at the elastic limit is found by both calc and exp to be about 1/100 of the energy absorbed before failure. This points to the desirability of considering the plastic state in analysis. It is not proposed that smaller safety factors be used, but that if true safety factors are known, more consistent and therefore safer designs are possible with no increase in cost. Article gives tables, diagrams and graphs.

Ec41. Peterson, F.G.E.
"How to Use Limit Design," Eng.News Rec.126:41-2, Jan. 2, 1941. Disc. 126:522-3, April 10, 1941.

Theory of limit design explained, typical problems, steps involved in applying limit design to a simple rigid frame.

Ec40. Goodrich, C.M.
"Limit Design," Eng. J. v.23 nos.1 and 5, Jan. 1940, pp.5-6 and disc. May pp.220-7.

General discussion giving philosophy of limit design and urging use of limit design in practice.

Ec29. Leibnitz, Maier
"Experiments with Clamped and Simple Beams of I Shape made of Steel St. 37," (In German) *Bautechnik 7 p. 319, 1929.* Also: *Stauhlbau 9, 1936.*

Fa. FAILURE OF BUILDINGS---STATIC TESTS

Fa50. Johnson, Carl B.
"Light Gage Steel Diaphragms in Building Construction," Paper presented at Natl. Spr. Meeting of Am. Soc. Civ. Engrs., April 1950.

Fa50. Peterson, Charles
"Behavior of Single Diagonally Sheathed Wood Diaphragms," Paper presented at Natl. Spr. Meeting of Am. Soc. Civ. Engrs., April 1950.

Fa49. Green, N.B., and Horner, A.C.
"Tests Establish Strength of Single Diagonally Sheathed Roof Structure," West. Constr. News August 15, 1949.

Tests to determine diaphragm action of the single diagonally sheathed wood structure toward its use on buildings to effectively resist lateral seismic and wind forces. Truss and diaphragm action, limitations in practice, conclusions, applications, recommendations; analysis of the tests in accordance with beam theory; relationship of the shear stress modulus of the model panel to that of the prototype; deflection of, and load at proportional limit for, a full size wood diaphragm; application to design of roof panels.

Fa49. Owen, J.B.B.
"Review of the Testing of Structures," Eng. Struct. N.Y. Academic Press, pp. 241-258, 1949.

Techniques for testing structures to destruction are reviewed principally as they apply to British practice. Loading and strain measurements, etc. An acoustic gage is discussed which may offer some improvement in stability over resistance gages.

Fa48. Hammill, H.B., Degenkolb, H.J., Dewell, H.D., Gould, J.J. and Nishkian, L.H.
"Tests of Timber Structures from Golden Gate International Exposition," Trans. ASCE 113:1123-1260, 1948.

17 trusses, 37 joints of structural frames, 3 15-ft. struts, and 103 laboratory specimens tested to failure.

Fa47. "The Rigidity and Strength of Frame Walls," No. R896. U.S. Dept. of Agr. Forest Service, Forest Prod. Lab., Madison, Wisconsin, 1947.

Engineering analysis and tests of small frame structures to determine the relative resistance of different types of frame wall construction to longitudinal thrust. Also a study of each integral part of the frame building, such as the lintels, floor system, roof system and stair well, with an effort to give a better understanding and appreciation of the principles involved in wall construction.

Fa35. Green, N. B.
"The Lateral Resistance of Bearing Wall Buildings," Pac. Coast Bldg. Officials Conference Bul. June 1935.

Fa35. Green, N. B., Horner, A. C., and Combs, Theodore C.
"Earthquake Resistance of Wood Floors Used as Diaphragms in Masonry Wall Buildings," Engr. News Rec. 114:871-5, June 20, 1935.

A summary of recent full size and quarter scale model tests, including working formulas and values for design. 28pp.

Fa34. LaBarre, and Converse, F. J.
"Lateral Load Research to Determine the Strength and Rigidity of Wood Floors as Diaphragms and of Brick Walls and Piers," Report of test of 37th St. School, Los Angeles, Calif. 1934.

A three-story, wood-joist, unreinforced brick bearing wall building with a central corridor having brick walls and concrete floors was tested. Purpose was to obtain fundamental information on the behavior of wood floors as distributing diaphragms for lateral loads, such as those produced by earthquake or wind, and to investigate the behavior of existing brick masonry when subjected to such loads. Qualitative and quantitative results. The school was 10 years old and appeared to represent approximately the average design and construction practice of the time of its erection. The effect of lateral forces apparently was not considered in the design of the building. Elastic load-deflection curves; photos; tables of test results.

See also: "Long Beach Floor Tests," Engr. News Rec. p. 142, Feb. 1, 1934; also July 12, 1934.

Fa34. "Lateral Resistance Tests," Engr. News Rec. July 12, 1934.

Stanford tests. Points up necessity for adequate connections between structural elements of a building to provide resistance to earthquake forces.

Fb. FAILURE OF BUILDINGS---HIGH EXPLOSIVE BOMBS

See also: Ec48 Baker

Fb44. "House Damage by HE Weapons Acting by Blast," REN 214 Revised. Research and Experiments Dept., Ministry of Home Security. British. March 1944.

Fb43. "Air Raid Damage Report," Ser. No. A4 Ministry of Home Security. British. Feb. 1943. (Also Ser. Nos. C1, C2, D4).

Fb43. "Damage to Steel Framed Buildings," R.E. 4 Data Compilation No. 26. Ministry of Home Security. British. Feb. 1943.

Fb43. "Effect of German HE Bombs on Industrial Structures," REN 224. Ministry of Home Security. British. May 1943.

Fb42. "Air Raid Damage Report," Ser. No. C4. Ministry of Home Security. British. 1942.

Fb42. "Bomb Tests of Materials and Structures," Engr. News Rec. v. 128 n. 5 pp. 185-7 Jan. 29, 1942.

Data made available by War Dept. as to resistance of various types of construction under actual bombing. Published by Office of Civilian Defense, Washington, D.C.

Fb42. "Damage to R.C. Framed Buildings," Data Compilation No. 32. Ministry of Home Security. British. 1942.

Fb42. "Damage to Single Story Buildings," RE 4 Data Compilation No. 2. Ministry of Home Security. British. May 1942.

Fb41. Bondy, O.
"London Letter on Buildings Under Bombing," Engr. News Rec. v. 127 n. 7, 11 and 21, Aug. 14, 1941 pp. 214-15 and (discussion) Sept. 11 p. 343 and Nov. 20 p. 711.

London report on structural damage from bombing; oblique hits on walls are more common than vertical hits on roofs; damage even from same size bombs is extremely variable; fireproofing of steelwork is particularly important; bearing wall buildings are especially vulnerable; material thicknesses required for bomb protection.

See also: Iron Age 148:42-5 Aug. 14, 1941; Steel 109:80-2 Aug. 25

Fb40. "Air Raid Damage Report - Dolphin Court Flats," Ministry of Home Security. British. Nov. 1940.

Fc. FAILURE OF BUILDINGS---ATOMIC BOMBS

Fc51. "International Bibliography on Atomic Energy; vol. 2, Scientific Aspects," Columbia Univ. Press. 880pp. 1951.

Fc50. "Atomic Energy and Physical Sciences," U.S. Atomic Energy Commission, Washington, D.C. 228pp. 1950.

Bibliography.

Fc50. Bowman, Harry Lake
"Bombs vs Buildings," Engr. News Rec. pp. 24-27 Jan. 26, 1950.

Photos of Japan A-Bomb damage. Chart of "Percent of Damage" vs dist from ground zero for various types of construction.

Fc50. U.S. Department of Defense and Atomic Energy Commission
"The Effects of Atomic Weapons," produced under direction of Los Alamos Scientific Lab., Los Alamos, N. Mex. 456pp. 1950. Available from Supt. of Documents, U.S. Govt. Printing Off., Washington, D.C.

Comprehensive summary of state of knowledge (as of 1950) of physical and biological effects.

Fc48. Tester, A. C.
"Effect of Atomic Bombing on Building Materials at Hiroshima, Japan," Geol. Soc. Bull. 58:787-94 pl. 1-4, Aug. 1948.

Study of effects of atomic bombing on stone due to heat, abrasion, etc.

Fc47. U.S. Strategic Bombing Survey, Physical Damage Division Report. "The Effects of the Atomic Bomb on Hiroshima, Japan," 1947.

Vol. I: Classification of buildings according to type for purpose of presenting damage in table form. 120pp. (All damage listed in Vols. I-III is designated either as superficial or structural. Superficial damage is defined as damage such as surface burns, etc., which does not reduce the load-carrying capacity of the structure. Structural damage is that which reduces the load-carrying capacity of the structure.)

Vol. II: Types of damage, fire cause and extent, damage to buildings.

Vol. III: Pictorial and graphical data are presented in an attempt to analyze the extent of damage to machine tools and bridges. Photos show extent of damaged buildings with characteristic patterns of failure of several types of structures and the effect on machinery contained within, caused by building collapse or flying debris.

Fc47. U.S. Strategic Bombing Survey, Physical Damage Division.
"The Effects of the Atomic Bomb on Nagasaki, Japan," 1947.

Vol. I: Classification of buildings according to type for purpose of presenting damage in table form. (All damage listed in Vols. I-III is designated either as superficial or structural. See Hiroshima report FC47.)
Part 1. Summary, general, miscellaneous information.
Part 2. Effects of Atomic Bomb on industrial structures.

Vol. II: Building type-damage tables.
Part 3. Effects of A bomb on public buildings.
Part 4. Effects of A bomb on public utilities.

Vol. III: Building type-damage tables.
Part 5. Effects of A bomb on machinery, equipment and plant utilities.
Part 6. Effects of A bomb on bridges and transportation systems.
Part 7. Fire damage effects of A bombs.
Part 8. Translations of Japanese Official and Industrial documents reporting results of A bomb attack.

Both of the above Strategic Bombing Survey reports give exhaustive damage analyses---a great many photographs are included; detailed reports on damage to individual buildings. Condensation available from Documents Div., U.S. Govt. Printing Off., Washington, D.C.

Fc46. "Effect on Structures of Atomic Bombs," Conc. and Constr. Engr. 41:205-9 Aug. 1946.

Abstract of report written by scientist sent by British Govt. to study effects of atomic bombs exploded over Japan; illustrations reveal damage on buildings of brick, reinforced concrete and steel.

Fc46. Praeger, E.H.
"Behavior of Concrete Structures Under Atomic Bombing," Am. Conc. Inst. J. v.17 n.6 pp.709-720 June 1946.

"The destruction wrought by atomic bombing of the Japanese cities, Hiroshima and Nagasaki, August, 1945, is outlined, with an analysis of typical damage within areas with respect to 'zero point.' The paper discusses principles and procedures of design necessary to resist attacks by these special new weapons."

Fd. FAILURE OF BUILDINGS---EARTHQUAKES

See also: Da34 Greskoff

Fd51. Alford, J.L., and Housner, G.W.
"A Dynamic Test of a Four Story Reinforced Concrete Building," Publication of Earthquake Engineering Research Inst. Aug. 1951.

Forced vibrations with measurements of deflections and accelerations of amplitudes approaching those experienced during strong-motion earthquakes. Results on damping: total is small; increases with displacement; independent of frequency.

Fd51. Birkenhauer, H.F.
"The Prevention of Destruction from Seismic Waves," Rpt. of Seis Lab., John Carroll Univ., Cleveland, Ohio. 92pp. 1951.

Comprehensive summary of work in Japan and USA. Criteria of earthquake damage. Extensive bibliography should be consulted for significant references.

Fd48. Robertson, R.G.
"Earthquake-resistant Structures; Seismic Factors and Use of Reinforced Brickwork in Quetta Civil Reconstruction," Instn.Civ.Engrs.J. v.29 n.3 pp.171-84 Jan. 1948.

Damages to structures caused by earthquakes in Quetta, Baluchistan, British India, in 1923, 1935 and 1941; measures to make buildings earthquake resistant. Gives seismic factors for different parts and types of structures. Formula for acceleration at top of independent-wall-type structure.

Fd36. U.S. Department of Commerce, Coast and Geodetic Survey.
"Earthquake Investigations in California, 1934-35," USCGS Spec.Pub. 201, 1936. 231pp.

Methods and results of intensive program. Includes vibration tests on many buildings. Also detailed analysis of damage to ordinary masonry buildings (exterior masonry bearing walls with interior load-bearing construction of wood, steel, or masonry; partitions, roof, and floor framing may be wood.)

Fd35. Green, Norman B., Horner, A.C., and Combs, Theodore, C.
"Tests Indicate Design Methods for Earthquake-Proof Timber Floors," Engr.News Rec. 114:871-875, 1935.

A summary of recent full-size and quarter-scale model tests of wood floors considered as diaphragms in masonry wall buildings.

Fd32. Freeman, John R.
"Earthquake Damage and Earthquake Insurance," 1st ed. 904pp. McGraw-Hill 1932.

Structural lessons and losses from the San Francisco and Charleston quakes; text book on earthquake-resisting structural design, design of earthquake resistant buildings; stress in structures determined by period and amplitude; studies of engineering data for earthquake-resistant construction.

Fd25. Dewell, Henry D.
"Earthquake Studies," Commonwealth Club of Calif. Trans. v.XX no.6, 1925. pp.226-233.

Contains chapter on "Building Against Earthquake and Shock." A critical analysis of construction defects in existing buildings with relation to earthquake damage and resistance.

G. DESIGN FOR IMPULSIVE LOADING

See also: Fd51 Birkenhauer, Da51 Whitney, Ec48 Baker, Ec44 White, Da50 Newmark Af45 "Steeltyd Reinforced---," Da50 Penzien, Eb42 Whitney

G51. Neal, Bernard George, and Symonds, Paul S.
"A Method for Calculating the Failure Loads for a Framed Structure Subjected to Fluctuating Loads," Instn. Civ. Engrs. J. no. 3 Jan. 1951.

The determination of the critical value of the load parameter for any framed structure which, if exceeded, would cause failure by incremental collapse. It is essentially an elastic-plastic problem which can not be solved without considering the elastic behavior of the frame.

G50. "Damage from Atomic Explosion and Design of Protective Structures," Dept. of Defense and AEC. 1950.

Abstracts of material from "Effects of Atomic Weapons" with recommendations on construction of protective structures.

G49. Swindlehurst, J.E.
"Structural Defense," Structural Eng. v.27 n.7 pp.295-304 July 1949.

Defense against explosives; explosions on surface, within building or below ground level; effect of atomic bomb; fully framed structures, whether of steel or of reinforced concrete, possess resisting properties superior in every way to those constructed with load bearing walls.

G48. Berling, G.
"Designing for Shock Resistance," Prod. Engr. Jan. 1948.

G48. Wimperis, H.E.
"Atomic Attack and Defense," Engr. v.186 n.4843 pp.511-2, Nov. 19, 1948.

Methods of active defense discussed.

G47. Turner, B.T.
"The Design of Oscillating Cantilevers," Aircr. Eng. pp.385-387 Dec. 1947.

Outline of methods used in designing such a cantilever for radar equipment, which may provide a basis for similar structures in aircraft.

G44. Wilbur, John B.
"Permissible Stresses for Use in Design Based on Elastic Analysis of Reinforced Concrete Beams Acted Upon by Impulsive Loads," Informal Prog. Rpt. no.23 (MIT), Off. Sci. Research and Development OEMsr-468, March 1944.

Tests indicate that in the design of typical fortifications, an amount of plastic deformation consistent with a reasonable factor of safety against important damage, be permitted under the controlling design loads. In this report a study is made of the test data given in "Impact Tests of Reinforced Concrete Beams, II," by Newmark and Richart (OSRD 1751) wherein the testing under varying impact loads of 104 reinforced concrete beams of varying reinforcement is described. Results of analysis given in tables. It was found that the "fictitious elastic strength" (using dynamic elastic analysis) of the beams in bending and shear failure, under dynamic loads, was ten times the static ultimate strength. The total energy applied to a beam to produce failure should be of the same order of magnitude. This hypothesis was correlated with energy considerations, and for design purposes he recommends that factors of safety of 3 and 4 be applied to the fictitious ultimate stresses for bending and shear.

G44. Wilbur, John B.
"Revised Procedure for Designing Roof Slabs to Resist Bombing," Informal Prog. Report no.24, Off. Sci. Res. and Development OEMsr-468 March 1944 (MIT)

G42. Wessman, H.E., and Rose, W.A.
"Aerial Bombardment Protection," Wiley, 372pp. 1942.

Detailed discussion on those measures which should be taken to make building construction resistant to effects of bombing. Characteristics of bombs, design procedures, present construction practice and proposed modifications, design of specific types of buildings, analysis of building requirements. Fairly comprehensive summary of status of knowledge as of 1942.